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DEVELOPMENT OF THE PROCARP AND CYSTOCARP IN THE GENUS PTILOTA.

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(WITH PLATES XVIII AND XIX)

THE following account of the structure and development of the procarps and cystocarps in the genus Ptilota is the result of the writer's studies begun in 1892 upon two Pacific coast forms. Later the points then worked out were verified in an Atlantic coast species, *P. serrata*, and this form, for reasons of convenience, was chosen as the type for the detailed description of the anatomy and development of the cystocarpic fruit. The account of *P. plumosa* and *P. plumosa filicina* is of the nature of a comparison with *P. serrata*. Most of the work was carried on in the cryptogamic laboratory of Harvard University under the direction of Dr. Farlow.

PTILOTA SERRATA Kütz.

This species is very abundant on the Atlantic coast north of Cape Cod, and fruiting specimens, either cystocarpic or tetrasporic, may be obtained readily in the proper season. The writer's material has all come from Nahant, Mass., and the cystocarpic plants have been found there as early as March and as late as May. Although cystocarpic fronds are abundant

and covered with fruit in all stages of development, the writer has never succeeded in finding any antheridial plants, although he has carefully searched all sorts of specimens, nor have any such ever been found on this coast to his knowledge.

For convenience the subject-matter of this description will be grouped under the following heads: (*a*) structure and mode of growth of the frond; (*b*) morphology and development of the procarpic branches; (*c*) development of the group of procarps; (*d*) minute structure of the procarps; (*e*) development of the cystocarp. The subjects included in the first two divisions will be treated in the briefest possible manner. At the end of the descriptions will be found a section which treats of the relation of the type of cystocarp found in Ptilota to that of allied genera, and also some remarks upon the physiological character of this method of carposporic reproduction.

STRUCTURE AND MODE OF GROWTH OF THE FROND.

The writer can add nothing to the thorough description of the structure of the frond of this genus first presented by Nägeli (47), and later more exhaustively considered by Cramer (63). However, a short account seems necessary to make clear the morphology of the parts of the fruit.

The branches of the frond, styled pinnæ, consist of a central axial siphon of large oblong cells or segments covered by a thick cortex of small cells. A large apical cell (*fig. 1, x*) terminates the axial siphon of the pinna, and by its repeated transverse division new segments are added to the axial siphon.

On the pinnæ, attached to alternate segments of the axial siphon, one on each side, are borne pairs of lanceolate structures called pinnules. In this species the pinnules are usually unequal in size, one being quite small, and their distribution is such that when a certain segment bears its large pinnule on the right hand side of the pinna, the next large pinnule above or below is attached to the left side of a segment. As the small pinnules are borne opposite the large pinnules, upon the same segments, their arrangement is of course exactly the same as the latter.

The segments of the axial siphon which bear the pinnules are called nodes and the segments between them internodes.

The larger pinnule of the pair begins to develop from the node almost immediately after the latter has been cut off from the apical cell. The nodal segment first grows out to one side, the side that is opposite to that of the young pinnule on the node just below it, and a cell is cut off. This cell is the earliest stage of a pinnule. It assumes the rôle of an apical cell, and by successive transverse divisions gives rise to a row of cells which becomes the axial siphon of the pinnule. When the larger pinnule is well under way in its development, the node gives rise to another cell on the opposite side of the pinna, and from this cell is developed the second pinnule, which rarely becomes as large as the first and sometimes remains quite abortive. Stages illustrating the above description may be seen in *fig. 1*.

Cells are cut off laterally from both sides of the axial siphon of the pinnule, and these by successive transverse divisions develop a system of lateral branches. The young pinnule then has the structure of a membranous tissue the thickness of a single cell, but it really consists of an aggregation of filaments, all in the same plane, each of which grows in precisely the same manner as the axial siphons of pinnæ and pinnules, viz., from apical cells.

The three systems of filaments, (1) the axial siphons of the pinnæ, (2) the axial siphons of the pinnules, and (3) the lateral branches from the axial siphon of the pinnules, are the framework which determines the shape of the frond. All other cells are part of the cortex proper. There is no cortex on the young pinnules and at the tips of the pinnæ, but on older portions of the frond its gradual development may be easily traced. Short branches grow up over the axial siphons in older parts, covering them with several layers of cells. This collection of cells constitutes the cortex.

The entire frond then consists of an elaborate system of filaments, and the growth of all parts is strictly from the terminal cells (apical cells) of the branches. A segment cut off from

the apical cell of a filament never divides except to give rise by lateral outgrowths to a new branch of the filament.

MORPHOLOGY AND DEVELOPMENT OF THE PROCARPIC BRANCHES.

The procarps of the genus Ptilota are found in certain specialized portions of the frond called procarpic branches. In *P. serrata* the procarpic branches for the most part take the place of the smaller pinnules usually found on sterile plants. They are therefore attached to the nodes of the pinnæ and situated opposite well developed pinnules. Procarpic branches are sometimes to be found on the edge of the pinnules, but they are not common in this species. The structure of the procarpic branches clearly shows their homology with the smaller pinnules, and their development is so similar that it is impossible to distinguish the younger stages from one another. Each adult procarpic branch contains an axial siphon which consists of from nine to twelve (typically ten) segments. Pairs of short lateral filaments arise from the segments in the same manner as in ordinary pinnules, and as the branch grows older a rather insignificant system of corticating filaments is developed. Several early stages of procarpic branches are shown in *fig. 1*, the cells being shaded. Those attached to the II, III, and IV nodes consist of but a single cell. Later stages are shown attached to nodes V, VI, and VII. A typical adult procarpic branch is illustrated by *fig. 3*, the specimen from which the figure was drawn being situated on the twelfth node of a pinna.

When procarpic branches are found on the pinnules they are seen to take the place of the teeth that usually occur along the edge of these structures, and to be continuations of the lateral branches from the axial siphon of the pinnules.

The extremity of the adult procarpic branch has the same structure whether the latter is situated on a pinna or pinnule. There is always a terminal cell, the former apical cell (*fig. 3*, cell II), and it is from this that the group of procarps is derived. The apical cell and all structures derived from it are

numbered eleven in the figures because it is usually the eleventh cell of the axial siphon of the procarpic branch.

DEVELOPMENT OF THE GROUP OF PROCARPS.

The group of procarps is always situated at the tip of a procarpic branch. The number is somewhat variable, but typically five. In order that the reader may follow more readily the account of the development of this structure it will be best to describe first the appearance of mature specimens. It is suggested that he glance at *fig. 10* where an adult group of procarps is shown.

There appear in this figure five trichogynes (numbered 11, 10′, 10′ᵃ, 10′′ and 10′′′), each of which terminates a short branch consisting of three or four cells. Three of these branches are figured; the other two could not appear in this view. Each branch with its trichogyne is a procarp. Three of the procarps, those numbered 11, 10′′, and 10′′′, are solitary. The other two procarps are peculiar in that they form a pair united together at the basal cells. The three lower cells of the solitary procarps and one of the basal cells of the pair are all united to the terminal segment of the procarpic branch (*fig. 10*, no. 10). The procarps may then be said to form a group around this terminal segment.

The union between the basal cells of the procarps and the terminal segment of the procarpic branch is effected by the strands of protoplasm so generally found between the cells of Floridеæ.

Bearing in mind the structure of the tip of an adult procarpic branch we may now consider the development of the group of procarps. A transverse division of the terminal cell of the procarpic branch (*fig. 2*, cell 10) initiates the development of the group of procarps. The division is somewhat oblique, so that the new terminal cell (*fig. 3*, cell 11) is pushed over towards the axis of the pinna, and the curvature of the procarpic branch is thus made more pronounced. This division is really simply a continuation of the apical growth of the procarpic branch, but

we are justified in laying emphasis upon it for the new terminal cell (*fig. 3*, cell 11) now developed immediately into a procarp. Therefore the segment 10 (*fig. 2*) may be said to terminate the procarpic branch, although really its axis continues through this procarp and only ends with its trichogyne. This procarp is the inner one of the group of procarps, the one nearest the pinna, and in all figures it has been numbered 11.

The development of this individual procarp may be taken as the type for all. The cell that gives rise to it (*fig. 3*, cell 11) divides transversely. The upper cell then elongates and also divides, and the terminal division becomes specialized into the trichogyne. The different stages in the development of this procarp are illustrated as follows. A two-celled stage is shown in *fig. 6*, no. 11, and the same condition appears again in *figs. 7* and *8*, except that in both cases the upper cell is much elongated preparatory to the development of the trichogyne. A half grown trichogyne appears in *fig. 9* (numbered 11) and the mature procarp is shown in *fig. 10*. It must be apparent that the position of this procarp, whether to the right or left of the center of the group, depends upon the side from which the procarpic branch is viewed. Its situation is always on the inside of the group, that is the side nearest the axis of the pinna. It is evident that the procarp follows the same type of growth as other parts of the frond. That is, the growth is from the terminal cell, and the structure is a short branch of three cells, one of which becomes specialized into the trichogyne. The number of cells in the different procarps varies, but the method of development is the same in all.

We may now consider the peculiar pair of procarps on the outside of the group. Beginning with the stage shown in *fig. 3*, we see that a cell (no. 10′) has been cut off from the terminal segment of the procarpic branch. This cell quickly develops into a short branch, usually of four cells, which curves inwards somewhat as is shown in the later stage (*fig. 4*). The cells of this branch are short and thick and lie closely pressed against one another. The terminal cell eventually becomes a

trichogyne. However, before this takes place the basal cell of the branch, that which is attached directly to the terminal segment of the procarpic branch (*fig. 4, c*) gives rise to a cell laterally. This condition is shown in *fig. 5*, cell 10′ᵃ. From this last is developed another branch of three or four cells. The two-celled stage is shown in *fig. 7*, and the three-celled condition in *fig. 8*, in both cases numbered 10′ᵃ. By the elongation of the terminal cell of this second branch the structure becomes a procarp. We have now two procarps of three or four cells each, lying side by side, united to the cell that was first cut off from the tenth segment. By examining the later stages of this pair of procarps (*figs. 7, 8,* and *9*) it will be seen that the trichogyne of the first procarp (procarp 10′) develops before the second. In fact it is usually the first of all the trichogynes in the group of procarps to mature.

It is well to call attention now to the fact, which will receive more detailed treatment later in the paper, that the cystocarp of *P. serrata*, in all cases that the writer has examined (some 112 in number), has always developed from the cell at the base of the pair of procarps. This carpogenous cell (*c* in *figs. 3–9*) is the first to be derived from the terminal segment of the procarpic branch, and therefore next to the basal cell of procarp no. 11 is the oldest cell of the group.

There remain to be considered the two procarps that lie between the inner procarp and the pair on the outside. As is shown in *fig. 10*, these two procarps are attached laterally to the terminal segment of the procarpic branch in such a manner that when viewed from the side one appears in front and the other behind this cell. Their development is precisely like that of the procarp on the inside of the group. A cell is cut off first on one side of the terminal segment and then on the other side (*figs. 5* and *6*, cell 10″). Each of these two cells then develops into a procarp of three cells in exactly the same manner as the other procarps develop. This is well shown in the figures of later stages (*figs. 7, 8,* and *9*). These two procarps are the last of the group to mature.

Contemporaneous with the development of the group of procarps is the luxuriant growth of the whorl of short filaments from the segment of the procarpic branch just below the terminal segment. Some of these filaments become the large bracts that surround the mature cystocarp. They develop, as do all the structures of the frond, by growth from the terminal cells of filaments, and *figs. 5*, *6*, and *10* illustrate the appearance of the chief stages.

The typical number of procarps in the group is five, but instances of over or under production are not infrequent. In cases where the number is less than usual the second procarp of the pair is most likely to be absent, and occasionally one or both of the lateral procarps may be suppressed. Examples of over production are more frequent, and perhaps the most common instance is that in which a pair of procarps is found in place of the inner procarp of the group. Sometimes an additional procarp may be attached to the basal cell of the pair. None of these irregularities transgress the law of development that we have advanced, for in all cases the procarps are short branches, the terminal cells of which have become specialized into trichogynes.

MINUTE STRUCTURE OF THE PROCARPS.

Now that we understand something of the development and arrangement of the procarps in the group, we are in a position to consider the minute structure of the cells. The material had been well fixed in chromic acid, and proved excellent for the examination.

In the first place, we may refer to the peculiar structure of the cell-wall often found around the young procarps, which is different from anything that the writer has ever seen described. Unlike the cell-walls on other portions of the frond, which are perfectly homogeneous in structure, the wall is here distinctly differentiated into an inner and an outer zone. *Fig. 4* may be taken as an excellent illustration of this peculiarity. This specimen had been stained with Böhmer's hæmatoxylin, and the

inner zone was much more strongly tinted than the outer. Even in fresh material and unstained specimens, the inner zone appears of a denser consistence. A most interesting peculiarity of this cell-wall is a series of radiating strands which arise from the edge of the inner zone and pass through the outer zone to the outer edge of the cell-wall (*figs. 4, 5, 6*, etc.). These radiating strands stain about as deeply as the inner zone, and appear to be of the same substance. This complex cell-wall is very common around the developing procarps, and is sometimes found, but not in such a characteristic form, at the apical cell of the pinnæ. The peculiar swollen appearance of the outer zone suggests the phenomena of gelatination, and to test this point the writer treated specimens with a hot solution of potassic hydrate. The consistence of the outer zone was quite unaffected by this treatment, instead of swelling or dissolving as substances of a gelatinous nature would have done. The writer was quite unable to obtain a cellulose test (using iodine and sulphuric acid), either with this curious cell-wall or with the ordinary cell-walls of this plant. But there are reasons from its general appearance and reaction towards stains for believing it to be at least closely related to cellulose, if it be not that substance.

Adopting the terminology of Bornet and Thuret we may divide the procarps into three portions: (1) the trichogyne, (2) the carpogenous cell, and (3) the portion of the procarp lying between these two, consisting of one or two cells, which we may call the trichophoric apparatus (*l'appareil trichophorique*).

We know certainly of but one carpogenous cell in the group of procarps, and this is the basal cell of the first procarp of the pair on the outside of the group. However, it is probable that the basal cell of each procarp is morphologically a carpogenous cell. At all events the following remarks on the structure of the cell that does give rise to the cystocarp are equally true of the basal cells of all procarps. The carpogenous cell at the time when the trichogyne is mature is the largest one in the procarp. It is slightly tinted with the red color of the Florideæ, but a well defined chromatophore cannot be made out dis-

tinctly. The central portion of the cell is a cavity containing cell sap, and the protoplasm with the irregular chromatophore forms a layer next the cell-wall. There is a distinct nucleus imbedded in the protoplasm, and as a rule a well defined nucleolus is apparent in specimens stained with hæmatoxylin (*figs. 11* and *12*, *c*). The carpogenous cell is connected below with the terminal segment of the procarpic branch, and above with the cell of the trichophoric apparatus, by a strand of protoplasm at each end.

The trichophoric apparatus consists of one or two cells according as the total number of cells in the procarp is three or four. There is a distinct nucleus in each cell, and the general appearance of the cell contents is very similar to that of the carpogenous cell, *i. e.*, the protoplasm containing more or less of the red pigment lies next the cell-wall and encloses a vacuole. In *figs. 11*, *12* and *13* the cell of the trichophoric apparatus is lettered *ta*. The position of the nuclei in the cells of the procarps has been shown in many of the figures. In some of the specimens (*figs. 5–10*) the stain was eosin, in others (*figs. 11–16*) the stain was hæmatoxylin.

The structure and development of the trichogyne now remain to be considered. This organ is very small and delicate, in this species of Ptilota measuring from 40–70μ long and 4μ wide in the thinner upper portions. The base of the trichogyne ("carpogonium," as Schmitz applied the term) is about as wide as the cell of the trichophoric apparatus directly under it, but it grows narrow very rapidly and runs into the very delicate and attenuated upper portion. The base of the trichogyne is not at all swollen, nor is there any constriction between it and the upper portion. The cell contents are hyaline in living specimens, and quite homogeneous. Stains do not bring out any differentiation of the protoplasm aside from a granular structure in the lower portion, and the writer has never seen anything that could be interpreted as a definite nucleus.

Such peculiar cytological structure of the trichogyne cell merits a farther examination, and the gradual development and withering of the organ will now be described. Starting with

the earliest stage, we find a cell at the end of a procarp closely attached to the cell of the trichophoric apparatus (*fig. 11, t*). Such a cell contains no distinct nucleus, but the cell contents often show a certain degree of differentiation into vacuoles and aggregations of granular matter. This cell begins to elongate, and as it does so carries up with it the substance of the inner zone of the cell-wall. Finally it pushes through the outer zone of the cell-wall (*fig. 12*), and then simply elongates until the full size is reached. The cell-wall of the upper portion of the trichogyne is composed entirely of the substance of the inner zone, the outer zone remaining around the base of the trichogyne as a sort of collar (*fig. 13*). As the trichogyne elongates the cells-contents become more homogeneous, until aside from some granular matter in the base of the structure there is no differentiation of the protoplasm. The trichogyne is united to the cell of the trichophoric apparatus by a narrow strand of protoplasm.

The first indication that the trichogyne is about to wither appears in the formation of a cap like layer of cellulose, staining deeply with hæmatoxylin, over the cell of the trichophoric apparatus, severing the protoplasmic connection between these two structures. An early stage in the differentiation of this cap is shown in *fig. 14*, and a later stage in *fig. 15*. Contemporaneously with the formation of this cap begins the disintegration of the trichogyne, and this latter process is always associated with the development of a zoogloea of rod-shaped bacteria (*figs. 14* and *15*), with sometimes Leptothrix and Beggiatoa filaments around the ends of the trichogynes. The end of the trichogyne gradually collapses, and the cellulose wall appears to gelatinize, for the outline becomes vague and at last we cannot distinguish the end in the mass of slime. The contents of the trichogyne either disappear entirely, or there are left only small masses of organic matter in the basal portion of the structure.

While the trichogyne is withering the cell of the trichophoric apparatus usually begins to push out at one side of the base of the trichogyne, and assuming the functions of an apical cell it converts the procarp into a filament of several cells that forms

one of a whorl of small bracts around the cystocarp. These filaments with the remains of the trichogynes at one side are frequently met with, and appear in some of the figures illustrating the development of the cystocarp.

We may say at this point that we have never seen any bodies attached to the trichogynes that could be identified as antherozoids. Such observations must be made before the trichogynes begin to wither, as then the bacteria and slime put a stop to all examination of this point. Sometimes the group of procarps contains much foreign matter around the trichogynes, but much of the writer's material was quite clean, and it seemed impossible that the presence of antherozoids should escape notice, yet such material was covered with developed fruit.

DEVELOPMENT OF CYSTOCARP.

We have already stated that the cell at the base of the pair of procarps is the carpogenous cell (*figs. 4–11, c*). It is very curious that the cystocarp should be developed so uniformly from a particular cell, and yet this proved true of every specimen that the writer examined. This cell is one of the first of the cells composing the group of procarps to be formed, and consequently is one of the oldest at the time when the cystocarp begins its development. It is likewise associated with the procarp that as a rule is the first of the group to mature. The development of the cystocarp was studied almost exclusively from serial sections cut from paraffin, the specimens being stained *in toto* with Mayer's acid hæmalum, and on the slide with eosin.

The earliest stage of the cystocarp is frequently met with It consists of a large cell rich in protoplasm, and containing a prominent nucleus, situated in the midst of the group of procarps and united to the carpogenous cell of the outer pair. A glance at *fig. 16* will make plain what is meant. The large cell numbered 10 is the terminal segment of the procarpic branch On the left side of the figure drawn in detail is one of the procarps of the outside pair, and from its carpogenous cell (*c*) has

arisen the first cell of the cystocarp (x). On the right side of the figure drawn in outline, only the position of the nuclei being indicated by shading, are the remains of some of the other procarps of the group with the basal portions of their withered trichogynes. Whenever dotted lines appear in the figures, they mean that the structures indicated were present in the section of the series next the one from which the drawing was made.

The carpogenous cell does not give rise to this first cell of the cystocarp until the trichogyne has begun to wither, and is therefore entirely separated from the cell of the trichophoric apparatus. The first cell of the cystocarp increases in size until it quite fills up the space between the procarps, and then by a transverse division it cuts off a small cell at its base. (*fig. 18*). The lower cell takes no further part in the development of the cystocarp; the upper cell gives rise to the lobes of the favella.

At this point it may be well to consider the possibility of there being cross-fusion between any of the cells of the procarps and those of the young cystocarp. The cells of the young cystocarp are separated from all the cells of the procarps by walls which stain heavily, as has been indicated in *fig. 17*. In none of the many specimens examined was there any indication of the presence of ooblastema filaments or of fusion processes budded out from any cell of the procarps. As the sections were serial the relation of all the cells of the procarps and cystocarps to one another might be studied, and it seems to the writer quite impossible that there could be any connections formed between any of the cells that would not appear on the slides.

The favella consists of a variable number of lobes, from two to five, which as a rule are in widely different stages of maturity. They are quite separated from one another, but are all attached to the second cell (cell x^2 in *figs. 19* and *20*) of the cystocarp. A lobe develops in the following manner. The second cell of the cystocarp pushes out in the form of a pear shaped process that becomes cut off as a cell. This cell by forward growth and a few irregular divisions gives rise to a short filament of thick

segments (*fig. 19*). Branches arise from these segments in profusion and secondary branches from the first, so that ultimately there results an oval body consisting of roundish cells, closely packed together, and yet really constituting a system of filaments. As the lobe matures the connections between the cells are severed and finally they separate as carpospores, quite distinct from one another. *Fig. 20* shows a section through a maturing cystocarp. Here there are three lobes shown in section and the attachment of two of them to the second cell of the cystocarp (x^2) is evident. The largest lobe was made up of ripe spores which were about ready to escape from the cystocarp; the other lobes were much younger. The remains of the procarp (*ta*) with the base of the trichogyne may be seen on the right of the figure.

As the cystocarp develops it frequently happens that the strands of protoplasm between the terminal cell of the procarpic branch and the carpogenous cell and between this last and the first cell of the cystocarp become much wider than they were originally. There is evidently an absorption of the cell-wall between these cells. In *fig. 20* the cell-wall between the terminal segment of the procarpic branch (no. 10) and the carpogenous cell (*c*) has been so far absorbed that were it not for the fact of a nucleus being present in the carpogenous cell, and its position in reference to the procarp and cystocarp, one would be likely to consider it a part of the terminal segment.

PTILOTA PLUMOSA C. AG. AND P. PLUMOSA FILICINA FARL.

The material upon which this examination is based was collected by the author in the month of July 1892 at Pacific Grove, California. In the following account of the structure and development of the procarps and cystocarps of this species and its variety we take it for granted that the reader is familiar with the main points of the account of *Ptilota serrata*. Accordingly the subject is considered under the same divisions and in the same order as those of the preceding description, and the

remarks will be in the nature of a comparison of these two Pacific coast forms with *P. serrata*.

STRUCTURE AND MODE OF GROWTH OF THE FROND.

The structure of the frond of *P. plumosa* and its variety *filicina* is in all essentials identical with that of *P. serrata*. The differences that exist are purely minor peculiarities of size and shape of pinnules and pinnæ, color, habit, etc. The structure of the framework upon which the corticating filaments are laid is quite the same in both species, and the method of growth of all parts of the frond is absolutely identical in the two forms.

MORPHOLOGY AND DEVELOPMENT OF THE PROCARPIC BRANCHES.

There is a more luxuriant production of fruit in the Californian species than on *P. serrata*. While procarpic branches are not rare on the pinnules of *P. serrata*, they are very commonly so situated in *P. plumosa* and *P. plumosa filicina*, and the greater part of the fruit is to be found on those portions of the frond. The procarpic branches on the pinnules, from one to five in number, are usually situated along the inner edge of that structure, where they take the place of the teeth found along the edge of sterile pinnules. The procarpic branches of the Pacific coast forms are shorter than those of *P. serrata*, in *P. plumosa* consisting of only five or six segments, and in *P. plumosa filicina* of eight or nine segments, the number of course being somewhat variable. The procarpic branches of the variety *filicina* are not only longer, but also stouter than in the typical form *plumosa*, in keeping with the coarser texture of the frond. Occasionally a procarpic branch will itself bear procarpic branches, that is, a lateral branch from the axial siphon, instead of developing into a vegetative filament, will give rise to a short branch upon the end of which a group of procarps will be developed.

DEVELOPMENT OF THE GROUP OF PROCARPS.

The group of procarps in its development follows exactly the same steps in *P. plumosa* and its variety as in *P. serrata*. A com-

parison of *fig. 22* with *fig. 7* will show that the two groups of procarps are identical in all the essentials of structure. There was no tendency towards an increase of the typical number of procarps in the Californian plants, but frequently the full number was not present.

The appearance of the pair of procarps on the outside of the group requires a word of notice. The second procarp of the pair is sometimes very small, and its position such that the question might arise as to whether it really is a filament or a number of cells cut off from the basal cell by radial divisions (*fig. 21*). In several such cases, specimens were treated with lactic acid and ammonia, when by carefully crushing the specimen and manipulating the cover glass, the two procarps were separated at all points excepting where the second joined the first at the basal cell. After such treatment it was apparent that the two procarps were distinct branches.

A very exceptional case was observed in the presence of a single procarp on the frond near the base of a pinnule, and in no way connected with a procarpic branch. It was attached to one of the lateral branches of a pinnule of *P. plumosa*, and consisted of three cells, the trichogyne projecting beyond the edge of the pinnule. This was the only exception noted to the rule that in the genus *Ptilota* the procarps are borne at the ends of procarpic branches.

MINUTE STRUCTURE OF THE PROCARPS.

With the general agreement in structure that we have found to exist between the different portions of the frond of the California plants and *P. serrata*, we should hardly expect to find great differences in the minute structure of the procarps. There are no essential differences in the structure of the carpogenous cells and the trichophoric apparatus. The trichogynes of *P. plumosa* and *P. plumosa filicina* are somewhat longer than in *P. serrata*, measuring about 62 μ long and 3 μ wide above the trichophore. In most cases it was quite impossible, after carefully staining, to make out any differentiation of the protoplasm

in this organ beyond a slight granular structure. However, the writer did find occasionally a body in the narrower portion of the trichogyne that had something of the appearance of a very small nucleus. There was a tendency toward a differentiation of the cell-wall around the procarps, manifest in the manner in which the upper portions of the trichogyne arose from a sort of collar, but the writer observed nothing that could be compared with the complex cell-wall of *P. serrata*.

No antherozoids were found attached to the trichogynes, and as yet no antheridial plants of this Pacific coast species have been found. However, the writer did not make the same determined search for male plants in this species as he did in the case of *P. serrata*.

DEVELOPMENT OF THE CYSTOCARP.

There is a perfect agreement in the structure of the cystocarp of *P. serrata* and the two forms we are considering. Not only do the lobes of the favella arise in the same manner, but they are developed from the same cell in both cases, this cell being the second cell of the cystocarp.

There does not appear to be the same uniformity as to the position of the carpogenous cell in *P. plumosa* and its var. *filicina* as in *P. serrata*. Out of thirty-five specimens of cystocarps examined, twenty-nine were developed from the basal cell of the pair of procarps on the outside of the group, the homologue of the carpogenous cell of *P. serrata;* four cystocarps came from the basal cell of the procarp on the inside of the group, and in two instances they had arisen from the terminal segment of the procarpic branch.

Three figures of different stages of the cystocarps have been introduced, which make clear certain points about their development that are not shown in the illustrations of *P. serrata*. In *fig. 23* we have an instance where the carpogenous cell (*c*) of the procarp on the inside of a group has pushed out towards the center and contains two nuclei. This the writer considers to be the earliest stage in the development of a cystocarp. The dis-

tinct nuclei of the cells of the trichophoric apparatus (*ta*) are shown, and above them the trichogyne, which has just begun to wither, may be seen. In *fig. 24* we have the one-celled condition of a cystocarp, and the specimen is of particular interest because the chromatin of the nucleus is very well defined, having apparently gathered together into the chromosomes preparatory to nuclear division. *Fig. 25* illustrates beautifully the manner in which a new lobe (b^1) arises from the second cell (a^2) of the cystocarp when an older lobe may be well along in its development.

COMPARISON OF THE TYPE OF PROCARP AND CYSTOCARP OF PTILOTA WITH THOSE OF ALLIED GENERA.

We have fortunately very good descriptions of the types of procarps and cystocarps of the genera most closely allied to Ptilota. The following have been carefully studied: Callithamnion,[1] Pterothamnion,[2] Griffithsia,[3] Ceramium,[4] Lejolisia,[5] Spermothamnion,[6] Ptilothamnion,[7] and Spondylothamnion.[8]

There are many differences in the precise cell arrangements of the procarps in the genera just mentioned, each having its peculiarities, and in none of them are the conditions very much like those of Ptilota. However, in the following two cases certain resemblances are worth noting.

In *Callithamnion elegans* Schousb., according to Bornet and Thuret (76), one of the segments of a branch gives rise to a cell from which is developed a three-celled procarp, the basal

[1] *Callithamnion corymbosum* Lyngb. Bornet and Thuret (67) 145; Thuret (78) 67. *pl. 33–35*. *C. tetricum* Ag. Janczewski (77) 117. *C. elegans* Schousb. Bornet and Thuret (76) fasc. 1: 32. *pl. 10*.

[2] *Pterothamnion plumula* Näg. Schmitz (83) 23, 24.

[3] *Griffithsia corallina* Ag. Janczewski (77) 122. *G. Bornetiana* Farl. Smith (96) 35.

[4] *Ceramium decurrens* Harv. Janczewski (77) 120.

[5] *Lejolisia Mediterranea* Born. Bornet and Thuret (67) 148.

[6] *Spermothamnion flabellatum* Born. Bornet and Thuret (76) fasc. 1: 27, *pl. 9*. *S. hemaphroditum* Näg. Janczewski (77) 115.

[7] *Ptilothamnion pluma* Thuret. Bornet and Thuret (76) fasc. 2: 179, *pl. 46*.

[8] *Spondylothamnion multifidum* Näg. Bornet and Thuret (76) fasc. 2: 182, *pl. 47*

cell of which is the carpogenous cell. Often this segment from which the procarp is developed gives rise to one or two cells that are ordinarily vegetative, but that sometimes become changed into procarps. When this is the case a group of procarps results somewhat resembling the group in Ptilota. The cystocarp consists of several lobes, but unlike Ptilota they all arise directly from the carpogenous cell.

In the genus Ceramium, according to Janczewski, there are found two procarps connected with one carpogenous cell. In Ptilota the pair of procarps situated at the outside of the group appears to have but one carpogenous cell. However, the manner in which the procarps of Ceramium develop is quite different from that of Ptilota, and a morphological relationship seems very unlikely.

REMARKS ON THE CHARACTER OF THIS TYPE OF CARPOSPORIC REPRODUCTION.

Physiologically considered there is a great resemblance between the type of carposporic reproduction of Ptilota and of the several genera previously mentioned. They all agree in that the carpogenous cell is separated from the trichogyne by a trichophoric apparatus consisting of one or more cells. This characteristic of the type is very important from a physiological standpoint, and so considered it matters little what is the precise number and arrangement of the cells of the trichophoric apparatus. Furthermore, if the writer is not mistaken in his interpretation of what has been published by the different writers on the subject, in the genera above named and also in the case of the species of Ptilota studied by him, no actual fusion of the base of the trichogyne with the carpogenous cell has been observed. In most of these genera and also in Ptilota the trichogyne is so far removed from the carpogenous cell that fusion would hardly be possible, except through the agency of an ooblastema filament. However, in spite of very careful search on my part no such filament could be found in Ptilota, nor have I seen in the literature any figure showing an ooblastema filament or any

explicit statement on the part of botanists that they have ever observed one in any of the genera just mentioned.

An exception to the above statement may perhaps be found in some remarks in a recent paper by Professor Fr. Schmitz,[9] in which he expresses the belief that the hitherto accepted accounts of the fertilization in Callithamnion are incorrect. It may be gathered from this statement of his opinion that he was inclined to believe that ooblastema filaments or their equivalent exist in Callithamnion, but the brevity of the account there given and the absence of figures prevents my comparing the complicated condition of things there described with what I have observed in Ptilota.

To bring clearly before the reader the conditions that make a satisfactory explanation of the fertilization of the carpogenous cell in Ptilota so difficult let us examine some of the figures. In the specimen shown in *fig. 24* the trichogyne had clearly begun to wither, and the carpogenous cell was in process of division. *Figs. 15*, *17*, and *24* illustrate the one-celled stage of the cystocarp, the trichogyne in all instances having withered to a certain degree. *Figs. 18* and *19* show later stages of the cystocarp with the withered trichogynes at one side of the procarps, and in *fig. 20* we have a section of an adult cystocarp that illustrates very well the relation between the cell of the trichophoric apparatus (*ta*) and the cell of the cystocarp when the latter is mature.

A glance at these figures must make it apparent that the trichogyne is so far distant from the carpogenous cell that fusion with it would hardly be possible except by means of an ooblastema filament. The writer has never seen anything to indicate the presence of such a filament, and it does not seem to him possible that such a structure could be present and escape notice in serial sections such as he had to study. There was

[9] *La Nuova Notarisia*, III.—: 114. 1892. The first view of Professor Schmitz (see *Untersuchungen über die Befruchtung der Florideen* 23, 24) was that in the majority of the Ceramieæ there is direct fusion between the base of the trichogyne and the carpogenous cell, brought about by the bending of the trichophoric apparatus so that the trichogyne is brought into close proximity to the carpogenous cell.

likewise no evidence of fusion between the cells of the developing cystocarps and the cells of any of the trichophoric apparatuses or the trichogynes. As is shown in all the figures, the cells of the cystocarp are separated from the trichophoric apparatuses by walls of considerable thickness, and cross-fusion of any sort certainly ought to have appeared in the sections. The fact that the sections were serial enabled the writer to examine all sides of the specimens, and would seem to have prevented the possibility of an ooblastema filament or fusion process escaping notice because it lay in such a plane that it could not appear in the median section. However, to guard against error of method the writer crushed out many of the young cystocarps in lactic acid, thus separating the procarps from the central developing cystocarp, and in such specimens saw no indication of an ooblastema filament.

A satisfactory explanation of a sexual process in the case of Ptilota must then be one which answers the following question: viz., How can a sexual impulse be transmitted from a trichogyne to a carpogenous cell when the two structures are separated by a trichophoric apparatus of at least one cell (often more) through which the impulse must pass? From the literature it certainly seems as if the conditions above mentioned were essentially the same in the genera Callithamnion, Griffithsia, Ceramium, Spermothamnion, Spondylothamnion, and Lejolisia, but the writer cannot in most cases speak from a personal study of the forms.

Accepting the dictum that biology now lays down as to the requirements of a sexual act, there must be a transmission of nuclear substance from the antherozoid through the trichogyne to the cells of the trichophoric apparatus, and thence on to the carpogenous cell. Any explanation of sexuality which satisfies the above condition must base its argument upon the fact of there being a continuous mass of protoplasmic matter from the trichogyne to the carpogenous cell, because of strands of protoplasm connecting the cells one with another.

The difficulties that a satisfactory hypothesis must overcome, even though it rest on the above mentioned fact of an

unbroken passage from trichogyne to carpogenous cell, are very great. It must postulate a process, the complexity of which, if the writer is not mistaken, is not to be found in the sexual reproduction of any organism. So far as the writer is able to judge, the union of sexual elements in both the animal and plant world is facilitated as much as possible by simplicity of conditions, *i. e.*, the two elements are given every opportunity to unite directly, and the direct union of the protoplasmic masses of two cells is the characteristic phenomenon of a sexual act. In this case it is necessary to assume the transmission of nuclear substance through cells which are themselves nucleated, and apparently are not specialized for this purpose, at least they are not materially different in structure from ordinary vegetative cells. The evidence upon this last point, it will be remembered, was that the cells of the trichophoric apparatus after the withering of the trichogynes increase in size and frequently give rise to a small filament or bract, thus showing that they have not lost the potentialities of vegetative cells. The passage of nuclear substance from one cell to another by way of one or more cells would be a fact quite contrary, the writer believes, to the usual conception of the individuality of the cell. Botanical science as yet furnishes no instance of such a phenomenon.

The writer carefully studied the cells of the trichophoric apparatus, endeavoring to find indications of a change in appearance before and after the development of the cystocarp, but in the many specimens he examined there was nothing to indicate a change of structure of the cells themselves, and nothing was ever seen that could be interpreted as nuclear substance *en route* to the carpogenous cell.

It must be apparent to the reader that we have to deal with a very difficult problem. From the observations here recorded an explanation of sexuality in this genus must overcome some serious obstacles. Investigators in this field of study have always considered that the sexuality of the Florideæ was an established fact. Yet in this genus the cytological conditions of the procarps are such that it is difficult to conceive the mech-

anism by which the nuclear substance of the antherozoid could be carried to the female cell. But to make the problem still more complex there is the fact that the antherozoids are apparently rare, if not wanting, and yet cystocarpic fruit is very abundant. From the present examination, somewhat unsatisfactory as including only two species, the writer cannot but think it very probable that the cystocarp in this genus develops non-sexually.

The evidence in favor of a theory of apogamy may be briefly summarized as follows:

1. The entire absence of bodies attached to the trichogynes that could be identified as antherozoids impressed the writer as being very significant.

2. Cystocarpic plants of *P. serrata* and *P. plumosa* with its variety *filicina* are common and bear immense quantities of fruit, there being as a rule a cystocarp at the end of every abortive pinnule (procarpic branch), and sometimes borne along the edge of the pinnules. Immense quantities of antherozoids, particularly as they are non-motile in the Florideæ, would be required to insure the development of such a profusion of cystocarps arranged in such a regular manner upon the frond, yet no antheridial plants of *P. serrata* or *P. plumosa* have been reported. It is natural to expect that antheridial plants will be found, as has been the case with *Ptilota elegans* Bonnem, but they ought to exist in great quantity to produce such a profusion of fruit if the cystocarp is to develop as the result of a sexual act.

3. The uniformity with which the cystocarp is developed from one carpogenous cell in the case of *P. serrata* and one of two cells in the case of *P. plumosa* can be explained in two ways. Either the cell has been specialized as the female cell, of which there is no evidence in its structure or position, or it is the cell which by virtue of its age and situation is best fitted to give rise to the fruit apogamously. As has been pointed out, the carpogenous cell is one of the oldest in the group of procarps, and perhaps for that reason it may be the cell strongest in potentialities, best prepared to develop the fruit. At all

events the uniformity of the position of the carpogenous cell adds another difficulty to be explained by a theory of sexuality, while it is but reasonable to suppose that when a plant adopts a method of apogamous development of its fruit certain cells, because of position or age affording perhaps greater nourishment, would be best fitted to undertake reproductive functions.

4. The absence of facts pointing to a fertilization of the carpogenous cell through the trichophoric apparatus, and the difficulty of understanding such a process, while affording simply negative evidence on the subject, nevertheless deserves attention, and appears to the writer as a point in favor of the hypothesis of apogamy.

THE UNIVERSITY OF CHICAGO.

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EXPLANATION OF PLATES XVIII AND XIX.

All figures sketched with the Abbé camera: *fig. 1*, × 300; *figs. 2* and *3*, × 800; *figs. 4–15*, × 1100; *figs. 16–22*, × 800; *figs. 23–25*, × 1100.

Ptilota serrata Kütz.

FIG. 1. End of a pinna; *x*, apical cell; I–VII, nodes; early stages of procarpic branches shaded.

FIG. 2. An adult procarpic branch from the twelfth node; stained with eosin.

Fig. 1a

Fig 2.

Fig 3.

Fig 4

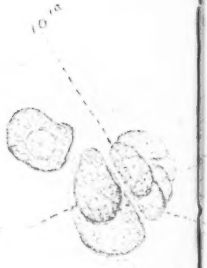

Fig 5

Fig 11.

Fig 12.

Fig 13.

Fig 14.

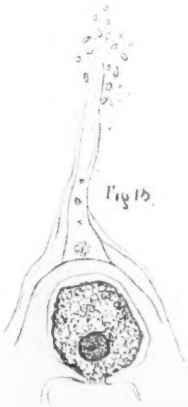

Fig 15.

acis del.

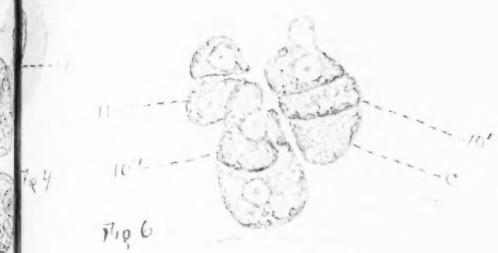

Fig 6

Fig 7.

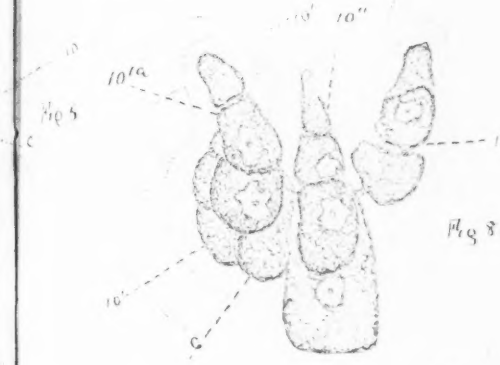

Fig 8.

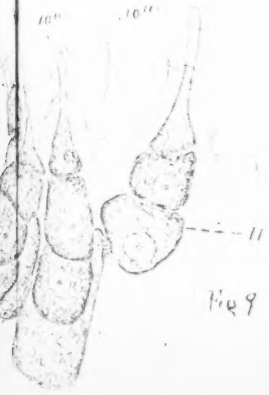

Fig 9

Fig 10.

Fig. 16.

Davis del.

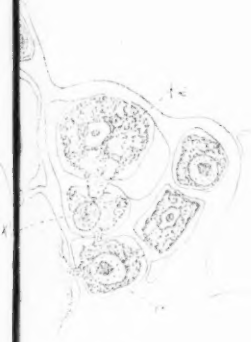

Fig. 18.

Fig. 24.

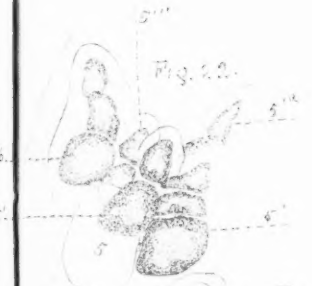

Fig. 22.

Fig. 23.

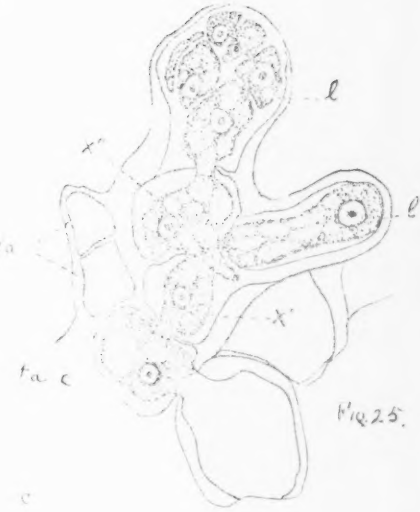

Fig. 25.

FIG. 3. End of procarpic branch showing first stage in the formation of the group of procarps; cell 11 gives rise to the inner procarp; cell *c* is the carpogenous cell; stained with eosin.

FIG. 4. End of procarpic branch showing structure of the cell-wall; branch 10′ becomes first procarp of the pair; stained with Böhmer's hæmatoxylin.

FIGS. 5–10 from specimens stained with eosin.

FIG. 5. End of procarpic branch: cell $10'^{a}$ gives rise to the second procarp of the pair; cell 10′′ develops into a lateral procarp.

FIG. 6. Stage very similar to *fig. 5*, inner procarp (no. 11) consists of two cells.

FIG. 7. Stage somewhat older in development than *fig. 6*; a trichogyne (10′) has developed from the terminal cell of the first procarp of the pair.

FIG. 8. A stage very similar to *fig. 7*, but viewed from the opposite side; lateral procarp 10′′ consists of three cells.

FIG. 9. Group of procarps illustrating development of the trichogynes.

FIG. 10. An adult group of procarps; shows the appearance and arrangement of the bracts below the group.

FIGS. 11–16 from specimens stained with Böhmer's hæmatoxylin.

FIG. 11. A single immature procarp; terminal cell (*t*) becomes the trichogyne; *ta*, the cell of the trichophoric apparatus; *c*, the carpogenous cell.

FIG. 12. Trichogyne pushing through the outer zone of the cell-wall.

FIG. 13. A mature trichogyne.

FIG. 14. The protoplasmic connection between the trichogyne and the cell of the trichophoric apparatus has been severed, and a wall of cellulose has been formed between the two structures.

FIG. 15. Withered trichogyne with zoogloœa of bacteria at the tip.

FIGS. 16–22 from specimens stained with Mayer's acid hæmalum and eosin.

FIG. 16. First stage in development of cystocarp; *x*, first cell of cystocarp; *c*, carpogenous cell; *ta*, trichophoric apparatus; on the right side drawn in outline are other procarps.

FIG. 17. First stage of cystocarp with old trichogyne attached to the procarp.

FIG. 18. Two-celled stage of cystocarp with old trichogyne attached to the procarp.

FIG. 19. Four-celled stage of cystocarp with old trichogyne attached to the procarp.

FIG. 20. A cystocarp with one mature lobe and two similar structures partially developed; *ta*, trichophoric apparatus; *c*, carpogenous cell.

Ptilota plumosa C. Ag.

FIG. 21. Early stage in development of group of procarps; about the same stage as is shown in *fig. 6* of *P. serrata*: cell 6 homologous with cell 11; 5′ with 10′; 5′′ with 10′′.

FIG. 22. Somewhat later stage than *fig. 21*, very similar to *fig. 7* of *P. serrata*; numbered to correspond with *fig. 21*.

Ptilota plumosa filicina Farl.

FIGS. 23–26 stained with Böhmer's hæmatoxylin.

FIG. 23. Carpogenous cell of procarp (*c*) with two nuclei; *ta*, trichophoric apparatus; probably a stage preliminary to the formation of the first cell of the cystocarp.

FIG. 24. One-celled stage of cystocarp; nucleus with a network of chromosomes.

FIG. 25. Cystocarp with early stages of two lobes of the favella, the younger (*l′*) still a single cell having just been formed from the second cell of the cystocarp (*x′′*).

THE PHALLOIDEÆ OF THE UNITED STATES.

II. SYSTEMATIC ACCOUNT.[1]

EDWARD A. BURT.

PHALLOIDEÆ, Fries. Syst. Myc. **2**:281. 1823.

Terrestrial fungi with mycelium forming ropelike strands and bearing spherical or ovoid fructifications—the "eggs"—which consist of a receptaculum and gleba enclosed by the volva; volva with thin outer and inner layers separated from each other by a broad gelatinous layer; receptaculum of various forms, with a pseudoparenchymatous wall of chambered structure, bursting through the apex of the volva at maturity and carrying aloft the spores; gleba deliquescing into a syrupy mass containing the very minute ($3–8\ \mu \times 1–2.5\ \mu$) ellipsoidal spores.

KEY TO THE GENERA.

I. Gleba borne on the outer surface of the receptaculum - PHALLEÆ
  1. Receptaculum consisting of a stipe along the upper portion of which the gleba is borne - - - - - *Mutinus*
  2. Receptaculum consisting of a stipe and pileus joined together at their apices; gleba on the upper surface of the pileus - - - - - - - *Ithyphallus*
  3. Receptaculum consisting of a stipe, pileus, and veil; gleba on the upper surface of the pileus - - - *Dictyophora*

II. Gleba borne on the inner surface of the receptaculum - CLATHREÆ
  4. Receptaculum lacking a stipe, consisting of obliquely anastomosing bars or of vertical columns joined together above - - - - - - - *Clathrus*
  5. Receptaculum clathrate above, stipitate - - *Simblum*
  6. Receptaculum consisting of a stipe divided at its upper end into free arms whose inner surfaces and flanks between neighboring arms are covered by the gleba - - - *Anthurus*

[1]Contribution No. XXXVII from the Cryptogamic Laboratory of Harvard University, prepared under the direction of Dr. W. G. Farlow.

Subfamily PHALLEÆ (Fries).

MUTINUS Fries Summa Veg. Scand. **2**:434. 1849.

Receptaculum consisting of a hollow stipe and lacking pileus and veil. Gleba borne on the outer surface of the upper portion of the stipe.

MUTINUS CURTISII (Berk.) Ed. Fischer.

Corynites Curtisii Berkeley, Grevillea **2**:34. 1873. Compare James in Bull. Torrey Bot. Club **15**:314. *pl. 86.* 1888.

Mutinus Curtisii (Berk.) Ed. Fischer, Saccardo's Syll. Fung. **7**:13. 1888.

Mutinus bovinus Morgan, Journ. Cincinnati Soc. Nat. Hist. **11**:147. *pl. 3.* 1889. Ed. Fischer, Untersuch. Phall. 92. 1890.

(?) *Caromyces elegans* Montagne Herb. 1850.

(?) *Corynites elegans* Montagne Sylloge Cryptogamarum 281. 1856.

(?) *Mutinus elegans* (Mont.) Ed. Fischer, Saccardo's Syll. Fung. **7**:13. 1888. Neue Untersuch. Phall. 39. 1893.

Stipe horn shaped, tapering gradually from the base to the apex, sometimes subtriangular in cross-section, hollow, white or pinkish below and bright red above, perforate at the apex, spore bearing part with the same structure as the rest of the stipe.

Plant 4 to 7^{in} in height with a stipe $\frac{3}{4}^{in}$ thick (10 to 17^{cm} by 2^{cm}). Growing in cultivated grounds and in woods. Ohio, *Morgan;* Connecticut, *Wright, Eaton, Thaxter;* Long Island, *Peck;* Massachusetts, *James.*

This plant is very distinct from the following species, being larger, with a stipe having its greatest diameter where it issues from the volva, and then tapering very gradually upward. Owing to an error in the dimensions of the plant as published by Berkeley in *Grevillea*, this species has been regarded as probably identical with *C. Ravenelii.* The authentic specimen upon which Berkeley's description was based is in the Curtis Herb. in a good state of preservation. It bears the following label and description which does not differ materially from that published:

"(5635) Corynites Curtisii, *Berk.!*

Hymenophorum stipitiform, tubular, thin, subtriangular, red, pitted above

the middle, tapering to an obtuse point. Apex covered with a semifluid brown substance of a fetid smell.

Conn. C. Wright (222)."

This dried specimen measures 4^{in} in length and has a stipe $\frac{9}{16}^{in}$ in diameter at its widest part where it leaves the volva (10^{cm} by 14^{mm}). In the published description Berkeley adds that the spore-bearing part is confluent in structure with the portion below. This specimen agrees well with Morgan's description and figure of *M. bovinus*. An alcoholic specimen, collected by Thaxter in Connecticut, and a dried specimen collected by Peck on Long Island, agree well with the Berkeley specimen and with Morgan's figure. *Corynites Curtisii* and *Mutinus bovinus* are undoubtedly the same.

I have not seen specimens or figures of *Caromyces elegans* Montagne. The description, although rather imperfect, seems to indicate its identity with *C. Curtisii* and *M. bovinus*. Ed. Fischer[2] states that he has seen a figure of Montagne's plant in Herb. British Museum which agrees well with Morgan's figure of *M. bovinus*. If this identity is established Montagne's specific name should be used for the plant.

Mutinus caninus (Huds.) Fries.

Phallus caninus Huds. Angl. **2**: 630.

Phallus inodorus Sowerby, Fung. *pl. 330*.

Phallus (*Cynophallus*) *caninus* Fries, Syst. Myc. **2**: 284. 1823.

Mutinus caninus (Huds.) Fries, Summa Veg. Scand. 2. 1849. *Cf.* Ed. Fischer, Vers. e. syst. Uebers. 55. 1886. Sacc. Syll. Fung. **7**: 12. 1888. Untersuch. Phall. 90. 1890. Morgan in Jour. Cincinnati Soc. Nat. Hist. **11**: 147. 1889.

Corynites Ravenelii B. & C. Trans. Linn. Soc. **21**: 149. *pl. 19*. 1855.

Corynites brevis B. & C. Curtis in Geol. and Nat. Hist. Surv. N. C. *Pt. 3. Botany:* 110. *Cf.* Bull. Torr. Bot. Club **7**: 30. 1880.

Mutinus brevis B. & C. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 147. 1889.

Mutinus Ravenelii (B. & C.). Ed. Fischer, Saccardo's Syll. Fung. **7**: 13. 1888.

Stipe hollow, cylindrical-fusiform, 2½ to 6^{in} long by ½^{in} or less thick (6 to 15^{cm} by 1^{cm}); spore bearing part one-third to one-sixth the total length of the stipe, oblong-ovoid or conical,

[2] Neue Untersuch. Phall. 39. 1893.

flesh-colored, perforate or imperforate at the apex; portion below spore bearing part tapering downward, white or reddish, mostly one layer of chambers thick. The chambers of the spore bearing part of the stipe have very massive walls—perhaps twenty layers of cells thick—and open as pits or winding tubes into the central cavity of the stipe; below this part they are thin walled, opening, if at all, through the outer wall.

Growing about buildings and in gardens and thickets. New England, New York, Pennsylvania and South Carolina, *various collectors*; Ohio, *Morgan;* Indiana, *Underwood;* Wisconsin, *Pammel.*

This fungus is quite variable with us. I have examined several collections made at points about Cambridge and Somerville, Mass., at Newport, R. I., and at East Galway, N. Y. Mr. C. H. Peck has kindly shown me the specimens in the New York State Herbarium of *Corynites Ravenelii* B. & C., collected by himself in New York, and of *Cynophallus caninus* (Huds.) collected by Warne in the same state. Authentic specimens of *Corynites Ravenelii* B. & C. and of *Corynites brevis* B. & C. in the Curtis Herbarium were examined. My thanks are also due to Professor Ed. Fischer of Bern and Professor Chodat of Geneva for alcoholic specimens of European types of *Mutinus caninus* (Huds.) collected by Professor Chodat in Biel, Switzerland, in 1894, and procured for me by Professor Fischer.

The careful examination and comparison of all of this material shows that there is no well marked character or group of characters by which *M. Ravenelii* (B. & C.) may be separated from *M. caninus* (Huds.). Upon superficial view the European types of *M. caninus* show the spore-bearing part to be rather more abruptly distinct in color ("determinate") from the lower part of the stipe than is generally the case in our specimens. But upon splitting the plants longitudinally, both show the same massive wall for the spore-bearing part with pits or tubes opening into the central cavity of the stipe in that region and with the same chambered structure lower down. For this reason, "spore-bearing part determinate" for *M. caninus* does not seem to be of value for separating it from *M. Ravenelii.*

One of the dried specimens of *C. Ravenelii* in the Curtis Herbarium discloses a portion of the surface of the spore-bearing part next to the central cavity of the stipe. The pits may still be seen. The specimens collected at Somerville, Mass., the structure of which has been shown in my account of the development of *M. caninus*, are undoubtedly the same as those of *Corynites Ravenelii* B. & C., and they show that, while the stipe is usually distinctly perforate at the apex, it may, nevertheless, be so minutely perforate and with the lips of the orifice so closely drawn together as to be fairly described as imperforate.

The variations observed in the abundant supply of material at Somerville show very clearly that our forms, called sometimes *Mutinus* (*Corynites*) *Ravenelii* and sometimes *Mutinus caninus*, are really the same species and cannot well be separated from *M. caninus* of Europe. The spore-bearing part may be quite as short in proportion to the total length of the stipe as it is in the European types, or it may vary to one-third the total length of the stipe in the same lot of material. The shorter the spore bearing part, the more acute it is likely to be in our specimens which I have seen. As the plant is much more frequent with us than it is in Europe, more variation would be expected in our form. It has therefore seemed best to slightly modify the old description so that it may comprehend as well the relative proportions in size of parts shown by our plant.

The specimen of *Corynites brevis* B. & C. in the Curtis Herbarium is identical with those of *C. Ravenelii* B. & C. and thus confirms Ravenel's statement[3] that *C. brevis* was merely an herbarium name for *C. Ravenelii* and was probably printed by an oversight of the author in Dr. Curtis's catalogue in the Geological and Natural History Survey of North Carolina.

ITHYPHALLUS Fries Syst. Myc. **2.** 1823 (subgenus).

Receptaculum consisting of a hollow stipe and of a pileus bearing the gleba upon its outer (upper) surface. Veil wanting.

[3] See Gerard, Bull. Torr. Bot. Club **7**: 30. 1880.

ITHYPHALLUS IMPUDICUS (L.) Fries.

Phallus impudicus Linn. Suec. *n. 1261.*

Phallus vulgaris Micheli, Nova plantarum genera 201. 1729.

Phallus fatidus Sowerby Engl. Fungi, *pl. 329.*

Hymenophallus Hadriani Nees, System der Pilze und Schwämme, 1817.

Phallus (*Ithyphallus*) *impudicus* Fries, Syst. Myc. **2**: 283. 1823. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 146. 1889.

Ithyphallus impudicus (L.) Fr. Ed. Fischer, Saccardo's Syll. Fung. **7**: 8. 1888. Untersuch. Phall. 84. 1890.

Stipe hollow, tapering at each end, with a wall several layers of chambers thick, joined at its upper end with the pileus by a recurved border; pileus conic-campanulate, showing its outer surface sculptured with reticulated ridges and crests after deliquescence of the gleba; veil wanting; volva white or pinkish.

Total height of plant 6 to 12^{in} (15 to 30^{cm}): stipe $1\frac{1}{4}^{in}$ (3^{cm}) thick; pileus 2^{in} (5^{cm}) high. Growing on the ground in woods. New England, *Farlow*, *Frost;* New York, *Peck*, *Gerard;* South Carolina, *Schweinitz;* Ohio, *Lea*, *D. L. James;* Missouri, *Trelease;* Nebraska, *H. J. Webber;* California, *Harkness.*

The size and form of *Dictyophora duplicata* and the surface of its pileus are so similar to *I. impudicus* that there is danger of mistaking that plant for *I. impudicus* in young stages if the veil of the former plant has not yet lost its connections with the under face of the pileus so as to hang freely below the pileus about the stipe.

ITHYPHALLUS RUBICUNDUS (Bosc) Ed. Fischer.

Satyrus rubicundus Bosc, in Magaz. des Gesellsch. naturf. Freunde zu Berlin **5**: 86, *pl. 6, f. 8.* 1811.

Phallus (*Leiophallus*) *rubicundus* Fries, Syst. Myc. **2**: 285. 1823.

Phallus (*Ithyphallus*) *rubicundus* Bosc. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 146. 1889.

Ithyphallus rubicundus (Bosc) Ed. Fischer, Saccardo's Syll. Fung. **7**: 11. 1888. *Cf.* Untersuch. Phall. 90. 1890.

Stipe fusiform, red, 6 to 7^{in} long by $\frac{3}{4}^{in}$ thick in the middle (15 to 18^{cm} by 2^{cm}), perforate at the apex; pileus conic-campanulate, with surface even; volva small, gray.

Growing on the ground in dry fields. Massachusetts, *Frost;* New York, *Schweinitz;* North Carolina, *Curtis;* South Carolina, *Ravenel;* Alabama, *Peters.*

Bosc's illustration and description of this plant suggest, except in coloration of the stipe, a form of *Phallus Ravenelii* B. & C., if the latter species ever occurs without its veil-like appendage under the pileus, or with this veil so reduced as to be overlooked. The outer surface of the gleba in Bosc's figure is quite even, showing, as in *P. Ravenelii*, no such reticulation of lines as exist in *D. duplicata* on the surface of its gleba, and which there mark the position of the reticulate crests and ridges of the surface of its pileus. The dried specimens in the Curtis Herb., marked *Phallus rubicundus*, show a striking resemblance to those of *P. Ravenelii*, even in their size. One of the specimens is so old that its pileus has become bared through deliquescence of the gleba. It shows the granulate or minutely wrinkled surface characteristic of the pileus of *P. Ravenelii.* It is greatly to be hoped that whoever may have the good fortune to find *I. rubicundus* will preserve in alcohol specimens of the mature plant and of its eggs for a study of its structural relationships.

DICTYOPHORA Desvaux, Jour. de Bot. (Paris) **2**:88. 1809.

Receptaculum consisting of a stipe, a pileus and a veil, the latter being formed from the same tissue that gives rise to the stipe and hanging from the upper part of the stipe as a conical, campanulate, or cylindrical net or membrane.

DICTYOPHORA RAVENELII (B. & C.) Burt.

Boletus phalloides John Ray, Herb. Vaillant (Herb. du Musée d'hist. nat. in Paris), according to Ed. Fischer, Untersuch. Phall. 87.

Phallus Ravenelii B. & C., Grevillea **2**:33. 1873. *Cf.* Farlow, Bull. Bussey Inst. **2**:247. 1878. Peck, Bull. Torr. Bot. Club **9**:123. *pl. 25.* 1882.

Phallus (*Hymenophallus*) *Ravenelii* B. & C. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**:146. 1889.

Ithyphallus Ravenelii (B. & C.) Ed. Fischer, Saccardo's Syll. Fung. **7**:11. 1888. *Cf.* also Ed. Fischer in Untersuch. Phalloideen 30 and 86, and in Neue Untersuch. Phalloideen 15 and 34. *f. 64–68.*

Ithyphallus cucullatus Patouillard, Jour. de Bot. 198. 1890. *Cf.* Ed. Fischer in Neue Untersuch. Phalloideen 34.

Stipe slender, tapering at each end, hollow; pileus conic-campanulate, with its surface granulate or minutely wrinkled after disappearance of the gleba; veil membranaceous, usually less than one-half of the length of the pileus, loosely attached to the stipe in the angle between the stipe and pileus; stipe closed at the apex by a thin membrane or finally perforate; volva pinkish.

Plant 4 to 7^{in} long (10 to 17^{cm}); stipe 3/4^{in} thick (15 to 20^{mm}); pileus 1 1/2^{in} high (2.5 to 3.5^{cm}). Growing in woods and fields about rotting wood. New England, *various collectors;* New York, *Peck;* South Carolina, *Ravenel;* Ohio, *Morgan.*

This species has been placed in the genus Dictyophora on account of its having a persistent membrane hanging about the stipe from the angle between the pileus and the stipe. This membrane is composed of the same tissue, the intermediate tissue *A* of my figures, which gives rise to the veil in *D. duplicata.* Differentiation of this tissue does not advance in *D. Ravenelii* to the final stage of making this membrane pseudoparenchyma, or is this final stage reached in the case of hyphæ composing the pileus in *I. impudicus* and in *D. duplicata,* yet no one would hesitate on that ground to use the term *pileus* in connection with those species. It seems best to apply the term veil to this membrane in *D. Ravenelii,* which looks like a veil, has the position of a veil, is composed of the tissue forming the veil in other species, and is likely to be regarded as a veil without question by every botanist meeting this fungus for the first time and attempting its determination.

I have as yet had no opportunity of studying this structure except in an advanced egg-stage, very kindly placed at my disposal by Professor Thaxter, but that a differentiation towards the stage of pseudoparenchymatous hyphæ exists in the structure seemed to be indicated by some laterally inflated hyphæ which were observed in the section, as well as by the persistence of the structure in a membrane which becomes torn away from the under surface of the pileus on the one side and from the wall of the stipe on the other, during elongation.

DICTYOPHORA DUPLICATA (Bosc) Ed. Fischer.

Phallus duplicatus Bosc, Magaz. des Gesellsch. naturf. Freunde zu Berlin **5**: 86. *pl. 6, f. 7.* 1811.

Hymenophallus duplicatus Nees, System der Pilze u. Schwämme. 1817.

Hymenophallus togatus Kalchbrenner, Gasteromycetes novi v. minus cogniti 6. *pl. 1.* 1884. *Cf.* Rau, A new Phallus, BOT. GAZ. **8**: 223. *pl. 4.* 183. Farlow, BOT. GAZ. **8**: 258. 1883.

Phallus (*Hymenophallus*) *dæmonum* Rumph. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 145. 1889. *Cf.* Tight, Bull. Sci. Lab. Denison Univ. **8**²: 7. *pl. 6.* 1894.

Dictyophora duplicata (Bosc) Ed. Fischer, Saccardo's Syll. Fung. **7**: 6. 1888.

Dictyophora phalloidea Desvaux, var. *Dictyophora duplicata* (Bosc) Ed. Fischer, Untersuch. Phalloideen 83. 1890.

Stipe cylindrical, tapering at each end, hollow, white, wall thick, with several layers of chambers; pileus campanulate, with surface sculptured with strong reticulating ridges and crests, which pass into the recurved border or collar formed by the union of the apex of the stipe with the pileus; veil reticulate, variable in length, but reaching down, usually, about half way from the apex of the stipe to its base. Meshes of the veil become smaller towards the lower border and the bars wider, so that the border is almost membranaceous. Apex of the plant with a large collar (truncate) and perforate, or more acute. Gleba dark green, with an extremely fetid odor.

Growing on the ground about buildings and about stumps in fields and thickets. Plant 6 to 9^{in} high (15 to 24^{cm}); stipe 1 to 1¼^{in} thick (2½ to 3^{cm}); pileus 2^{in} high (5^{cm}). This is a frequent species in the eastern United States and is reported from Ohio by Morgan, and specimens from Iowa have been contributed by Professor Fink. It has sometimes been confused by American botanists with the tropical *D. dæmonum* (Rumph.) and is frequently met with in collectors' lists under that name. The affinities of *D. dæmonum* (Rumph.) seem to be rather with *D. phalloidea* var. *typica* Ed. Fischer than with *D. duplicata*.

Ed. Fischer has regarded *D. phalloidea* Desvaux as a comprehensive species including four subspecies or varieties, of which *D. duplicata* is one. This seems to be too sweeping a combination. A. Möller's[4] excellent photographs of *D. phalloidea* var.

[4] Brasilische Pilzblumen, Jena, 1895.

typica, the variety nearest to *D. duplicata*, seem to afford sufficient ground for regarding the two as distinct species on account of the difference in the form of the pileus and in the almost membranaceous character of the marginal portion of the veil of *D. duplicata*.

Subfamily CLATHREÆ (Fries).

CLATHRUS Micheli, Nova plantar. genera 214. 1729.

Receptaculum wanting a stipe, consisting of a hollow clathrate structure of obliquely ascending and anastomosing bars, or consisting of a few vertical columns joined together at the apex (Laternea). Gleba inclosed within the receptaculum.

CLATHRUS COLUMNATUS Bosc.

Colonnaria urceolata, truncata, etc., Raf. Med. Repos. 1808, according to Gerard in Bull. Torr. Bot. Club **7**: 30. 1880.

Clathrus columnatus Bosc, Mag. Gesell. naturf. Freunde zu Berlin **5**: 85, *pl. 5. f. 5*. 1811. *Cf.* Ed. Fischer, Saccardo's Syll. Fung. **7**: 18. 1888.

Clathrus colonnarius Leman, Dict. Sc. Nat. **9**: 360. 1817.

Laternea columnata Nees, Nees and Henry's System der Pilze **2**: 96. 1858.

Laternea angolensis Welwitsch and Currey, Trans. Linn. Soc. London **26**: 286. 1870.

Clathrus angolensis (Welw. and Curr.) Ed. Fischer, Saccardo's Syll. Fung. **7**: 19. 1888.

Laternea columnata (Bosc) Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 149. 1889.

Laternea pusilla B. & C. Jour. Linn. Soc. Bot. **10**: 343. 1869.

Clathrus Berkeleyi Gerard in litt. Ed. Fischer, Saccardo's Syll. Fung. **7**: 18. 1888.

Clathrus triscapus Mont. Gay Historia fisica y politica de Chile Bot. **7**: 497. 1850.

Clathrus Brasiliensis Ed. Fischer, Versuch. e. syst. Uebers. 68. 1886.

(?) *Laternea triscapa* Turp. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**: 149. 1887.

Clathrus (*Laternea*) *australis* Spegazzini, Anales de la Sociedad cientifica Argentina **24**: 66. ——

Clathrus cancellatus Tourn., vars. *Berkeleyi, Brasiliensis, columnata*, and *australis*. Ed. Fischer, Untersuch. Phalloideen 55. 1890.

Laternea columnata (Bosc) A. Möller, Brasilische Pilzblumen. 1895.

Receptaculum consisting of 2 to 5 massive vertical columns separate below but joined together at the apex; columns cinna-

bar-red; gleba suspended from underneath the apex of the receptaculum. Odor very fetid.

Plant 2 to5 ^{in} in height. Growing in sandy soil. N. Carolina, *Curtis;* S. Carolina, *Bosc, Ravenel;* Georgia, *Le Conte;* Florida, *Ravenel, Mrs. Curtis, Underwood, Rolfs;* (?) Texas, *Ellis.*

The number of columns composing the receptaculum has been regarded by some botanists as a sufficient distinction for making several species from this plant. The variations in the number of columns in plants from the same locality and even in the same lot of material show that this character is not of the importance assumed. I have followed A. Möller in slightly modifying Bosc's original description so as to include the forms with two and five columns which occur in the tropics. Ed. Fischer seems to have gone too far in combining *C. columnatus* with *C. cancellatus. C. columnatus* in all of its forms seems to be sufficiently distinct from the other species in the massive structure of its columns and in their vertical position, the latter difference dating back in its origin to the earliest stage in the differentiation of the egg.

Judging from Morgan's description, the *Laternea triscapa* Turp., collected by Ellis in Texas, hardly seems distinct from the three-columned form of *C. columnatus*, which occurs in Florida.

Clathrus cancellatus Tourn.

Clathrus cancellatus Tourn. (see Tulasne in Expl. Scien. d'Algerie, Bot., Acotylédones 434). *Cf.* Ed. Fischer, Saccardo's Syll. Fung. **7**:19. 1888. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**:148. 1887.

Clathrus ruber, albus, flavescens, Micheli, Nova plantar. genera 214. 1729.

Clathrus volvaceus, Bull. Champignons. *pl. 441.*

Clathrus nicæensis Barla (see Luerssen Handbuch d. sys. Bot. **1**:275. 1879.

Clathrus cancellatus Tourn. var. *typica* Ed. Fischer, Untersuch. Phalloideen 58 1890.

Receptaculum spherical or obovoid, cancellate in all parts; bars transversely wrinkled, from 4^{mm} to 1^{cm} wide, cinnabar-red or white or yellowish on their outer surface, inner surface of bars red; meshes irregularly polygonal. Odor very fetid.

Plant 3 to 5[in] in height. Growing on the ground in woods. New York, *Clinton;* Georgia, *Le Conte;* Florida, *Faxon.*

SIMBLUM Klotzsch, Hook. Bot. Misc. **79**[2]:164.

Receptaculum consisting of a hollow stipe, which passes above into a hollow clathrate structure inclosing the gleba.

SIMBLUM SPHÆROCEPHALUM Schlechtendal.

Simblum sphærocephalum Schlecht. Linnæa **31**:154. *d. pl. 1.* 1861–62.

Simblum pilidiatum Ernst, Grevillea **6**:119. 1878. *Cf.* Ed. Fischer, Saccardo's Syll. Fung. **7**:16. 1888. Untersuch. Phalloideen 50. *f. 47.* 1890.

Simblum rubescens Gerard, Bull. Torr. Bot. Club **7**:8. *d. pl.* 1880. *Cf.* Ed. Fischer, Saccardo's Sylloge **7**:16. 1888. Untersuch. Phalloideen 59. *f. 46.* 1890. Morgan, Jour. Cincinnati Soc. Nat. Hist. **11**:148. 1889.

Simblum rubescens Gerard, var. *Kansensis* Cragin, Bull. Washburn Coll. Lab. Nat. Hist. 34. 1885.

Receptaculum long-stipitate; the clathrate portion depressed-globose, red or flesh-colored; the bars compressed, thinner than the stipe-wall, transversely wrinkled; meshes polygonal; stipe flesh-colored above, paler below, tapering towards the base, strongly constricted at the place of union with the clathrate portion.

Plant 3 to 5[in] in height (7 to 12[cm]); stipe ½ to ¾[in] thick (12 to 15[mm]); clathrate portion with greater diameter than the stipe. Growing in grassy ground. Long Island, *Gerard, Trask,* and others; Nebraska, *Webber.*

ANTHURUS Kalchbrenner, Grev. **9**:2. 1880.

Receptaculum consisting of a hollow stipe divided above into arms, which are unconnected at their apices. Gleba covering the inner faces of the arms.

ANTHURUS BOREALIS Burt.

Anthurus borealis Burt, Memoirs Boston Soc. Nat. Hist. **3**:504. *d. pl. 49, 50.* 1894.

Solitary or subcespitose. Stipe white, divided above into six, usually, but sometimes five or seven, narrowly lanceolate hollow arms; arms incurved above, with pale flesh-colored

backs traversed their entire length by a shallow furrow; cavity of the stipe nearly closed at the base of the arms by a diaphragm through which there is an opening upward into a closed chamber with a dome-shaped wall; gleba supported on the dome and closely embraced by the arms; spores 3 to 4 μ × 1.5 μ, borne on cross-septate basidia constricted at the septa.

Total height of plant 4 to 5^{in} (10 to 12^{cm}). Growing in cultivated fields. New York, *Burt*, 1893, *A. E. Burt*, 1894, in an asparagus bed, *Peck*, 1896; and in a low meadow, Westboro, Mass., *F. L. Sargent*, 1894. Mr. Sargent states that in the specimens found by him the arms varied in number from five to seven.

One of the mature plants of the original collection has three of its six arms joined together at the upper ends, showing an approach toward the conditions in the genus Colus. The plant is quite normal in all other respects, and the conditions under which it was collected preclude the idea of its being more than a variation of *A. borealis*.

Lysurus Texensis Ellis. Gerard in Bull. Torr. Bot. Club **7**: 30, 1880, mentioned a plant to which this name was given provisionally. The description has not been completed.

I am under great obligation to Dr. Farlow for the use of books and for access to the specimens of the Phalloideæ in the Curtis Herbarium; and also to Professor Peck for the privilege of examining the Phalloideæ in the New York State Herbarium at Albany, N. Y.

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SALIX CORDATA × SERICEA.

N. M. GLATFELTER.

THE general aspect and specific characters of *Salix cordata* and *S. sericea* serve to distinguish them quite readily. There have sprung up between them numerous intermediate forms, hybrids, and races, crossing with each other and with the parental forms, resulting in an almost inextricable confusion, on the one hand approaching *S. sericea*, on the other *S. cordata*. This free intermixture resulting in more or less good varieties in different localities is no doubt the sufficient explanation of the confusion that results from reading the various descriptions of *S. cordata*. As in all probability the descriptions were all founded upon specimens collected from regions where both of the species are native, it is absolutely certain that about the same complications must have been present as are found prevailing in the vicinity of St. Louis.

During the preparation of my paper last year on *S. Missouriensis* and *S. cordata* [1] I gradually got the feeling of the great necessity of further investigation of this subject. I therefore made collections in bud, in flower, and in mature leaf, of several hundred marked plants, taking notes of every detail. The summary at the end of this paper is but a partial transcript of the notes of eighty-two of those collected. In the Engelmann Herbarium of the Missouri Botanical Garden there is a long letter written about 1880 by the late M. S. Bebb, in which he refers to the frequent hybridization of *S. cordata* with *S. sericea*. He gives a fairly good description of these hybrids, but appears to have limited too much the extent of their influence. For example, he limits the height to 9ft, while some of our specimens here rise to 25 or 30ft. The specimens he contributed all

[1] Trans. St. Louis Acad. Sci. 7:—. 1895.

show more or less silkiness of capsules, and where there is silkiness of capsule or leaf, even but sparingly, the problem is easy. The evidence now at hand, however, compels the extension of the idea of contamination. By taking account of every possible character, we find that hybrids, or rather intermediate races, include many examples having capsules perfectly smooth, and all but the youngest leaves likewise perfectly smooth.

Upon the *S. cordata* side of our problem it is perhaps impossible as yet to form a proper conception as to its typical character, either from description or observation. An intelligible and comprehensive description of it is yet to be written, and must be founded upon specimens collected from regions where *S. sericea* is not found.

Fortunately in the characters of *S. sericea* we have rigid stability, a fact which furnishes us an invaluable guide to a partial exploration of the mazes of hybridization. Having examined specimens from Massachusetts, New York (Ithaca), southern Pennsylvania, Ohio, Michigan (Detroit and Port Huron), Illinois (Chicago), Missouri (Pilot Knob and St. Louis), and the Rocky mountains, I have found no noteworthy variation. Specimens of *S. cordata* were examined from New Brunswick, Niagara Falls, Ohio, Illinois, Iowa, Missouri, Minnesota, Colorado, Idaho, Oregon, California, and Kew Gardens.

Notwithstanding the variability of *S. cordata*, taking a general view of it together with its varieties, including var. *vestita* and its hybrids with *S. sericea*, there is presented as a whole such an *ensemble* of stem, spread, color, foliage, flower and fruit as to enable one to distinguish it easily from all other species. The interest in this paper must lie therefore rather in biology than in systematic botany.

Assuming but one form of *S. cordata*, and one good variety, viz., var. *vestita*, and knowing the freedom with which each crosses with *S. sericea*, we shall have, theoretically, the following combinations: cordata × sericea, cordata × vestita, sericea × vestita, and cordata × sericea × vestita. I think these combinations are recognizable in the vicinity of St. Louis. But a more

nearly correct idea of the true state of the case may be realized if the reader will bear in mind the two parent species and then imagine every possible form of gradation and combination producing races capable of self-propagation. If left to themselves without further contamination from their surroundings many would develop into good species. Var. *vestita* (*S. Missouriensis* Bebb) may thus be accounted for, which will be noticed later.

The modification of characters generally proceeds along the whole line with more or less equal pace, though often strong and weak modifications of one parent will be found indiscriminately combined with strong or weak modifications of the other, on the principle stated by Darwin "of augmentation, obliteration and reversion of characters when well defined varieties are crossed." When the departure from pure *S. sericea* is not too great, the increasing size of the stipules, the degree of discoloration in drying, the basal variation from the acute towards the cordate, the amount of silvery pubescence on the leaves are tolerably fair measurements of the distance. Beyond this the problem becomes more complicated. Taking our point of view from *S. sericea*, the important change first occurring is in the capsule. It loses its silvery pubescence, enlarges, lengthens in style and pedicel, assumes a somewhat flattish subrhomboidal base supporting a long or short beak with often a tendency to curve, ripens a pale tawny color, and has stigmas less deeply notched, often remaining entire.

The next important character early lost is the short, silvery, hairy coating of the under surface of the leaves. Instead, the leaves become more or less glaucous beneath, or the short hairs are transformed into the longer softer hairs seen on the young leaves of *S. cordata*. Var. *vestita* affords an extreme illustration of this process of change. No other character has received or demanded so much study as the one of pubescence or hairiness. Extremely variable in amount as to leaf, bud, shoot or twig, or absent altogether, variable also on scale and rachis, it is not a character of much value.

The third important change is in the scales. The scale

with broadly rounded apex and upper half black with sharp line of demarcation becomes narrower, oblong or obovate, with obtuse or acute apex dark to light brown, the line of demarcation less sharp and descending lower until it may be lost altogether.

Other changes follow, or are coincident with the preceding. The decided brittleness of *S. sericea* changes to semi-brittleness, to be finally lost in the toughness of *S. cordata*. The leaves become thicker, more glaucous beneath, subglossy above, losing the dull dark green upper surface, the prominent primary veins beneath, and the regular looping near the margin. They become larger, often long narrow lanceolate and long acuminate, the base changing from acute to obtuse, to round, and finally to cordate. The equilateral form in some instances becomes elliptic, in others oblanceolate or obovate, but in any case gradually loses the equilateral character.

From a total absence of stipules, or mere rudimentary processes, the change is rapid towards large semiovate or semicordate sharply pointed or acuminate, then to mixed, and finally to obtuse reniform forms, nearly all more or less stalked, this last being a new character not existing in either parent.

The bud of *S. sericea* is oblong, blunt, relatively short, notched at the apex, very finely exhibited in bursting. While the shape is soon lost in numerous variable forms, a common one being long wedge acuminate, the notch, though lessening in distinctness, often becomes a valuable aid in determining hybrids. The adherent inner membrane of the buds of *S. sericea* detaches itself in hybrids spontaneously, as in *S. cordata*, and is frequently carried as a cap on the apex of the ament.

The red color of the anthers of *S. sericea* is transmitted to the well marked hybrids, gradually changing, however, through brown or pale pink, into the yellow of *S. cordata*. The numerous prominent circular lenticels of *S. sericea* are still abundant in the better hybrids, becoming more and more mixed with the oval form as we approach *S. cordata*.

In *S. sericea* the epidermis of one and two year old twigs scales longitudinally, a character well retained by hybrids.

In this vicinity there is found on *S. sericea* a leaf gall, pyriform or globular in shape, about $\frac{1}{4}^{in}$ in diameter, enclosing a single larva of a species of saw-fly (*Nematus Salicis-pomum* Walsh), kindly identified for the writer by Miss Mary E. Murtfeldt of Kirkwood, Missouri. The same has been observed on some of the hybrids and on var. *vestita*, on two trees of the latter in extraordinary abundance. Not a single one have I seen on *S. cordata*, or on specimens approaching near to it, though growing side by side with those just mentioned! This fact is of the greatest importance, because it unites with a number of other facts showing that var. *vestita* is closer to *S. sericea* than to *S. cordata*.

Besides the transformations above noticed, the tendency to abnormalities has to be added. "Complexity of inheritance, like complexity in a chemical substance, gives instability to the offspring and thus liability to variation in the offspring."[2] The adnateness of filaments to the extent of 40 per cent. in hybrids, and 73 per cent. in var. *vestita* as shown in the summary, may be one of these abnormalities, but may be the usual character of *S. cordata*, though not heretofore noticed by any writer consulted. Related to this are cases where partly adnate filaments divide, making four filaments, each with a single anther cell; or the two filaments free, one of them dividing, thus making three stamens; or but a single stamen; or single stamen divided, each half filament bearing a cell; or the two stamens wholly united, bearing a double anther of four cells. More rare than the foregoing is the doubling of the ovary. There are also a few cases of strictly two-lobed styles, but more common are instances presenting both two and four-lobed styles on the same ament. In var. *vestita* the style is occasionally undivided, presenting a merely circular stigma, or with very indefinite divisions. The size of these hybrids may seem surprising, but all of our forms of *S. cordata*, as well as *S. sericea*, exceed the limits of the books. Pure *S. sericea* attains the height of 15^{ft}, with a diameter of $2\frac{1}{2}^{in}$, though usually only 5 to 10^{ft}. As to our *S. cordata*, it is impos-

[2] LECONTE: Evolution, 218.

sible to assign limits, since it passes so gradually either into the hybrid form, or into var. *vestita*, this latter reaching a height of 40^{ft} and a diameter of 10^{in}. A remarkable thing is that *S. sericea* is quite rare, a pure specimen being found only amongst hundreds. I have spent a day in a region of some extent collecting undoubted hybrid forms, *S. cordata.*, and var. *vestita*, without meeting with one pure *S. sericea*. This seems to prove clearly that these forms are not direct crosses but races. Indeed, I have been struck with the tendency of the plants in different localities to assume a sort of family resemblance.

The flowering period of *S. sericea*, its nearer hybrids, and var. *vestita*, is about the same; that of *S. cordata* and of hybrids approaching it is some days later. Honey bees appear to be the chief agents of pollination. In so many of the larger hybrids I have observed the bark of the lower portion of the trunk to be check-fissured, though of moderate depth, as to incline me to consider this as somewhat characteristic; but I have seen the same occasionally in trees which would be classed as var. *vestita*. The color is a dark gray or blackish. The bark of the *S. sericea* stem is smooth, and of light gray color. The arcuate primaries or looping near the margin of the leaf of *S. sericea* is a strong character, and is quite persistent in most of the hybrids; in other respects the venation generally resembles that of *S. cordata*.

In respect to the form named *S. Missouriensis* Bebb, I may be pardoned for regarding it as simply a race not separable either from *S. cordata* or the near hybrids, with nothing to distinguish it from these excepting, perhaps, its greater size or more tree-like form, and even this may be largely accounted for by the fact of the large trees being found growing in the richest soil. I have observed the same tree-like form, with hairy leaves, and of the same general aspect, growing in poorer soil, reduced to small stature. Its characters throughout are a compromise between *S. cordata* and *S. sericea*, with a closer leaning towards the latter. When compared with proven hybrids or races of those parents the resemblance is striking. The shape, color, vesture, thickness, drying color, want of gloss of the leaf, all

point towards *S. sericea*, as do the mostly round lenticels, the pointed stipules, the brittleness, the lithe twigs, the unfolding of the leaves towards the tip of the spray, and the leaf galls mentioned above. The instinct of the insect does not fail to detect the close alliance. I found this variety growing over the county wherever I collected: at Allenton and Valley Park belonging to the Meramec basin (trees 40^{ft} high); north of Clayton, at the River Des Peres (trees 35^{ft} high); near Fergusson, on upland ravine emptying into Moline creek (tree 30^{ft} high and 7^{in} in diameter). It can no longer be said, therefore, that it is confined to the rich bottom lands of the Missouri. I deem it unnecessary to say more on this point, as a reference to the summary will bear out the claims here made. It will be observed that having set down the variations of a character relating to a specimen the totals of such character will exceed the number of plants represented in that group.

In the comparison presented of *S. sericea* with *S. cordata* it is believed that a tolerably fair exhibit is given, at least sufficient to make evident the strong contrast between the two. Yet the writer has to confess the wish that his knowledge of *S. cordata* were more definite, and hopes that some one who has it in his power to secure sufficient material will undertake the task of a thorough review of this species remarkable for its free miscegenating proclivities, for besides *S. sericea* it also hybridizes with *S. petiolaris*, *S. candida*, *S. adenophylla*, *S. incana*, and *S. discolor*, none of which grow in this vicinity. I am under special obligations for specimens loaned by the following gentlemen: Professor J. Fowler, Canada; Mr. E. P. Sheldon, Minnesota; Professor F. D. Kelsey, Ohio; Professor L. H. Pammel, Iowa; Dr. William Trelease, Missouri Botanical Garden.

COMPARISON OF THE CHARACTERS OF SALIX SERICEA AND S. CORDATA.

S. sericea.	*S. cordata.*
Usually small shrub, with slender stems, not over 15 feet high.	Larger, tending to the tree form.

Twigs lithe, very brittle, nearly smooth, brown or olive green to light gray.

Epidermis thin, scaling.

Buds brown, oblong, blunt, notched at apex, inner membrane adherent.

Lenticels circular, numerous, prominent, brown or cinnamon color.

Leaves lanceolate, equilateral, base and apex acute; primary veins strong, prominent beneath and looping very regularly; upper side very dark green, under side subglaucous, coated with short silvery hairs; thin, drying black, and mostly affected with leaf galls; young leaves without color; serrulate.

Stipules none.

Aments about 1 inch long, with 2 to 5 leaflets, not tufted at base; scales short, broadly rounded, upper half black and clothed with rather stiff white hairs.

Filaments entirely free; anthers red.

Capsules short, oblong, blunt, clothed with short silvery hairs, bursting early; pedicel and style short; style 4-parted.

Blooming probably a week earlier.

A fixed, rigid species, with constant characters.

Tough, heavy, tomentose, blackish or blotched, changing to red or yellowish green and dark green.

Thick, firm, unbroken, not scaling.

Larger, ovate or wedge acute or the point flat, not notched, tomentose, then bright red or brown, inner membrane separating, being often carried to apex of ament.

Oval, relatively few, not prominent, color the same.

Apparently two forms: (1) long lance acuminate, (2) oblong-lanceolate, narrow or broad, cuspidate-acuminate; both obtuse to cordate, thick, inequilateral, glossy green above with a tinge of yellow, glaucous or subglaucous beneath; primaries relatively weak and looping only towards apex; drying yellowish green or light brown; young leaves downy above, hairy beneath, reddish.

Large, auriculate or reniform, obtuse (rarely acute), persistent.

Staminate 1.5 to 2 inches long, pistillate 2 to 4 inches, with 2 or 3 leaflets, tufted at base with long white hairs; scales narrower, oblong, obtuse to acute, light to dark brown, with softer more woolly hairs; gland longer.

Mostly more or less adnate; anthers yellow.

Mostly with subrhomboid, somewhat flattish base and narrowing to a beak of about equal length, or ovoid conical, not maturing so early; style long or medium, usually 4-lobed.

Variable with change of locality, and in same locality.

SUMMARY OF THE RECORD OF FIFTY-ONE SPECIMENS OF SALIX CORDATA × SERICEA, AND THIRTY-ONE SPECIMENS OF S. "MISSOURIENSIS."

		S. CORDATA × SERICEA			S. "MISSOURIENSIS"		
		STAMINATE [1]	PISTILLATE [2]	PER CENT.	STAMINATE [3]	PISTILLATE [4]	PER CENT.
Number recorded		28	23		15	16	
Twigs	brittle	13	12	53	9	5	47
	semibrittle	6	6	25	7	11	60
	tough	6	4	21	2	2	13
Buds notched		11	14	49	5	4	39
Lenticels	round	23	20	90	14	15	94
	oval	19	14	69	13	11	80
Leaf form	lanceolate	15	15	59	7	8	48
	narrow lanceolate	16	12	55	2	1	10
	oblong lanceolate	11	7	35	12	10	71
	elliptic	2	4	12	9	7	51
Leaf texture	thin	15	5	54	9	9	62
	thickish	9	8	46	5	6	38
Leaf surface (under)	glaucous	6	2	16	13	14	87
	subglaucous	22	21	84	2	2	13
Leaf surface (upper)	dull dark green	10	13	45	8	8	53
	yellowish green	5	4	18	0	0	0
	glossy	13	7	39	6	8	47
Leaf base	acute	21	21	82	9	13	71
	obtuse	25	18	84	15	16	100
	cordate	6	1	14	5	5	32
	subcordate	3	4	14	9	4	42
	round to truncate	5	7	23	1	5	19
Leaf apex	acuminate	27	23	98	9	10	61
	cusp.-acuminate	1	0	2	9	11	64
Stipules	pointed, semiovate	24	20	86	11	10	68
	obtuse, reniform	11	5	31	13	14	87
	stalked	16	7	68	5	4	35
	sessile	9	2	32	7	10	65
Color of young leaves	purplish	8	4	32	8	4	39
	reddish	5	1	15	0	2	6
	slight tinge	9	1	26	2	2	13
	colorless	6	4	26	5	8	42
Filaments	free	24	0	60	4	0	27
	adnate	16	0	40	11	0	73
Anthers	red or brown	23	0	80	9	0	64
	yellow	15	0	54	12	0	86
Stigmas	4-lobed	0	15	70	0	9	56
	2 to 4-lobed	0	7	32	0	7	44

ST. LOUIS, MISSOURI.

[1] Flowering March 29 to April 14; 15 were 15 to 25 feet high and 2 to 6 inches in diameter.

[2] Capsules ripe April 18 to 21; 12 were 15 to 25 feet high and 2 to 5 inches in diameter.

[3] Flowering March 29 to April 12; 11 were 20 to 30 feet high and 3 to 7 inches in diameter.

[4] Capsules ripe April 18 to 21; 13 were 20 to 35 feet high and 4 to 7 inches in diameter.

BRIEFER ARTICLES.

BRASSICA JUNCEA.

DR. ROBINSON'S note on page 252 of the September GAZETTE, recording the rapid dissemination of *Brassica juncea* in the eastern states, recalls the fact that this species is a common inhabitant of gardens. It is known as a pot-herb, and is variously called Chinese broad-leaved mustard, brown mustard, and Chinese mustard. A somewhat full account of this and related oriental brassicas, which are now cultivated in this country, is given in Bulletin 67 of the Cornell Experiment Station ("Some recent Chinese vegetables"), with illustrations. It is now a question whether these naturalized plants are introductions of the weedy *Brassica juncea* from the Old World, or whether they are spontaneous derivatives from the garden forms. A study of the plants in the field could no doubt settle this question.—L. H. BAILEY, *Cornell University*.

NORTH AMERICAN SPECIES OF EUPHRASIA.

IN preparing my monograph of the genus Euphrasia[1] I tried to make clear the extremely polymorphic forms which are to be found in North America. In this connection I wish to correct an error in one of the maps of the memoir, caused by a very unfortunate mistake, and one which I did not observe in the proof. I can distinguish three species of the genus Euphrasia in North America, as follows:

1. *E. Americana* Wettst. Near to the European *E. nemorosa* Pers., and as yet known only from eastern Canada.

2. *E. latifolia* Pursh. Distributed throughout the arctic regions of Asia and Europe, throughout Greenland, and extending into Cumberland and eastern Labrador.

3. *E. Oakesii* Wettst. A most distinct form, which as yet has been

[1] Monographie der Gattung Euphrasia. 4to, pp. 316, pl. 14. Leipzig, Engelmann, 1896.

found only in the White mountains of New Hampshire. By a mistake the range of this species was indicated in map I of my monograph as being in western North America. The error is not fatal, or even serious, as in the text (p. 173) the region is indicated properly. I should like to call special attention to the blunder, however, and to ask that area 12 on map I be stricken out.

A species which possibly occurs in North America, but whose presence cannot be proved as yet with certainty, is *E. hirtella* Jord. I found three specimens of it in the herbarium of the Royal Museum at Berlin, mixed with specimens of *E. Americana*, and ticketed "*E. officinalis*, flora boreal-Americ. (*Hooker*)."—RICHARD VON WETTSTEIN, *Prag, Austria.*

ABORTIVE FLOWER BUDS OF TRILLIUM.

DURING a course of study upon the development of pollen grains, an attempt was made to secure early spring buds of Trillium. Plants taken from beneath the still frozen soil near Ithaca on April 5 were examined. Among fifteen plants one bud was found about 15^{mm} in length, in which the pollen mother-cells had already separated from one another and were undergoing nuclear division. The other fourteen plants had minute buds 3^{mm} or less in length, in some cases the leaves of the perianth being distinguishable with the naked eye, in others only a slight projection above the receptacle being made out. Some of these small buds were treated with collodion and sectioned, when the sepals were found to be clearly differentiated, but within was only a confused mass of cells, many of them apparently dead, with almost no differentiation of petals, stamens, and pistil.

On April 15 a large number of plants just appearing above ground were collected. Only a small proportion contained healthy buds, and in these the pollen mother-cells were in the later stages of division, or, in some cases, the pollen grains were already formed. Sixty plants in which there were no growing buds were examined with a hand lens. In only three or four did the lens fail to show some traces of a bud, in some cases, as before, only a slight elevation. Usually the rudiment of a perianth could be distinguished, either as a white speck or as very evident floral leaves, sometimes 2 to 3^{mm} in length, but withered and evidently abortive.

As care had been taken to collect plants with indications of buds,

it is not certain that there were not truly sterile plants in the field, but the observations were sufficient to show that a large number of those that would be regarded as sterile at a later date had made an attempt to produce blossoms and had been more nearly successful in the case of the outer leaves than of the sporophylls.

The early development of the buds of spring flowers has been referred to by different writers. Foerste[2] mentions among the buds collected in Vermont, August 22–28, one of *Trillium erythrocarpum* 5.5^{mm} in length. The present writer found in central New York, on July 11, a flower bud of *T. grandiflorum* 2^{mm} in length, with anthers 1.7^{mm} long. There was no opportunity to learn the stage in the development of the pollen.—Arma A. Smith, *Cornell University*.

A STUDY OF SOME ANATOMICAL CHARACTERS OF NORTH AMERICAN GRAMINEÆ. VII.

(WITH PLATE XX)

THE GENUS AMPHICARPUM.

Only two species are known of this singular genus, *A. Floridanum* Chapm. and *A. Purshii* Kth., their geographical distribution being limited to the eastern United States, along the Atlantic coast. They both grow in sandy soil, but while *A. Floridanum* does not occur outside the semi-tropical Florida, the other species shows a larger range of distribution, from New Jersey as far south as Georgia. Their manner of growth is different, *A. Purshii* being cespitose, while *A. Floridanum* is stoloniferous, but otherwise they show a rather similar appearance, especially in regard to their floral characters, both developing their fruits underground, as true geocarpic plants. By comparing their leaf-structure we shall see that according to their distribution, and the character of the soil wherein they grow, the anatomical differences are but slight, and almost wholly dependent upon the development of the epidermis. These divergences, slight as they are, prove nevertheless sufficient to enable us to distinguish the two species anatomically.

Amphicarpum Floridanum.—The epidermis of the superior face of the leaf (*fig. 2*) consists generally of thick walled cells, which vary considerably in size and shape according to their disposition, whether

[2] On the relations of certain fall to spring blossoming plants, Bot. Gaz. 17: 1. 1892.

they belong to the strata that cover the mesophyll or the stereome. Those covering the mesophyll are either developed as bulliform cells (*B C*, in *fig. 2*) with nearly straight walls, or as ordinary epidermis cells with numerous stomata (*S*, in *fig. 2*). The cells of the stomatiferous strata have distinctly undulate cell walls, and these strata form longitudinal bands on both sides of the bulliform cells. Very different from these strata are those which cover the stereome (*A*, in *fig. 2*). Here we find cells of very different size, short and almost fusiform, or rather long, but all showing numerous foldings of the cell walls. Two forms of epidermal expansions are to be found here, viz., some which are short, one-celled and thorn shaped, and small hairs consisting of two cells (*H*, in *fig. 2*). This structure is to be found on the entire surface of the leaf in regular alternation and with almost the same number of rows in each stratum (*fig. 2*). There is in this way nothing to indicate the median part of the blade, for it shows no larger development of the bulliform cells, and, as will be shown later, the median mestome bundle and its surroundings do not show any histological difference from those of the lateral parts of the blade.

If we consider the epidermis of the inferior face of the leaf we find only a few differences from that of the superior one. The hairs seem here to be most frequent in the stomatiferous strata; the cells which surround the stomata are exceedingly thick walled, and no proper bulliform cells are developed, so that the stomatiferous strata occupy the entire space between those which cover the stereome. As shown in *fig. 3*, the epidermis of the inferior face shows a certain development approaching that of bulliform cells, but widely different from *A. Purshii*, which exhibits true bulliform cells on the inferior face of the blade.

The mestome bundles are of a very uniform development, and, as stated above, the median bundle is not more prominent than the others. Only two forms may be distinguished, but the difference is relatively smaller than we have seen in the other genera described in our previous articles upon this subject. Both forms of mestome bundles are surrounded by a completely closed and colorless parenchyma sheath (*P*, in *fig. 5*), inside of which is a mestome sheath of thick walled cells. The larger bundles show the presence of a single layer of thick walled mestome parenchyma, separating the leptome from the hadrome; and in the smaller bundles this parenchyma is absent. The smaller bundles appear to be the more numerous.

The stereome (*St*, in *fig. 5*) is well developed in this genus, and forms groups above and below each mestome bundle. On the inferior face of the leaf the stereome is sometimes bordering immediately on the parenchyma sheath, but is also seen to be separated from this either by the adjoining mesophyll or by colorless parenchyma. The stereome of the superior face is constantly separated from the parenchyma sheath by one to three cells of colorless parenchyma. The stereome has attained its highest development, however, along the margins of the blade (*fig. 4*). We see here an enormous group of this tissue connecting the two faces of the leaf, and by this character Amphicarpum is readily distinguished from any of the other genera which we have previously examined and described.

The mesophyll occupies quite an extensive part of the leaf blade, and forms usually separate groups between the mestome bundles, excepting where it passes uninterruptedly underneath these, between the stereome and the parenchyma sheath. It forms a compact tissue with the cells radiating from the mestome bundles, and no lacunes are observable. The colorless parenchyma has already been touched upon above, and we have seen it developed as a closed parenchyma sheath and as small groups or single cells between the stereome and the mestome bundles. As shown in *fig. 1*, it has attained its highest development on the superior part of the leaf.

Amphicarpum Purshii.—The epidermis of both faces of the leaf shows very nearly the same structure as we have described for *A. Floridanum*, but we note the following differences: The bulliform cells are here equally well developed on both faces (*fig. 6*); epidermal expansions as very long unicellular hairs are frequent on both faces, and are especially common in the bulliform strata. The thorn shaped expansions in this species seem to be most common in the stomatiferous strata, near the bulliform cells. The mestome bundles do not seem to differ from those of the other species, and the same is true of the mesophyll and the stereome. The colorless parenchyma is less developed on the superior face than we have seen in *A. Floridanum*. *Fig. 6* represents a transverse section of the median part of the leaf, and we see here only one single cell of colorless parenchyma above the parenchyma sheath, while below this the sheath borders immediately on the stereome.

In comparing the leaf structure of these two species of Amphicarpum, the principal anatomical differences are as follows:

Epidermis—

Long unicellular hairs on both faces	*A. Purshii*
No long hairs	*A. Floridanum*
Bulliform cells well developed on both faces of the leaf	*A. Purshii*
These restricted to the superior face	*A. Floridanum*

Mesophyll—

Forming separate groups between the mestome bundles	*A. Purshii*
Sometimes united	*A. Floridanum*

Colorless parenchyma—

Small groups separating the stereome of the superior face from the parenchyma sheath	*A. Floridanum*
Frequently only a single cell	*A. Purshii*

The leaf is altogether thicker and of firmer structure in *A. Floridanum* than in *A. Purshii*, a fact that perhaps indicates the warmer and drier climate of the region to which *A. Floridanum* belongs.—THEO. HOLM, *Washington, D. C.*

EXPLANATION OF PLATE XX.

FIGS. 1–5. Transverse sections of the leaf of *Amphicarpum Floridanum*.

FIG. 1. The median part of the blade, showing fine mestome bundles and fine groups of bulliform cells on the superior face; *Sup*, the superior face. × 165.

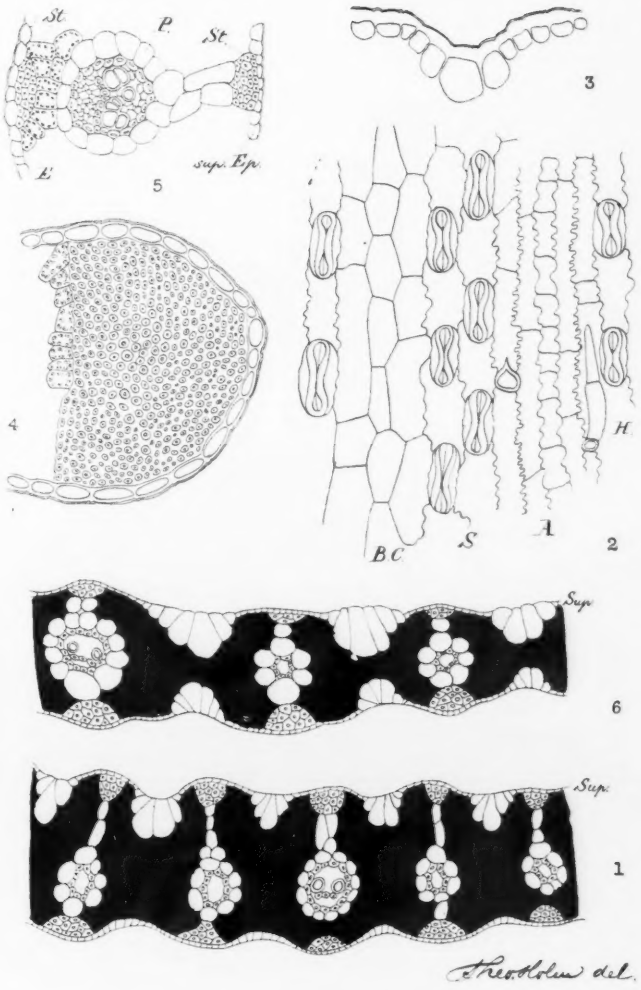
FIG. 2. Epidermis of the superior face, seen *en face; B C*, bulliform cells; *S*, the stomatiferous strata; *A*, the strata which cover the stereome; *H*, a hair. × 500.

FIG. 3. Group of epidermis cells from the inferior face, showing a structure somewhat similar to that of proper bulliform cells. × 500.

FIG. 4. The margin of the blade, showing the enormous development of stereome. × 330.

FIG. 5. One of the largest mestome bundles; *P*, the colorless parenchyma sheath; *St*, the stereome; *Ep*, the epidermis. × 330.

FIG. 6. Transverse section of the leaf of *A. Purshii*, showing three mestome bundles and three groups of bulliform cells on both faces; *Sup*, the superior face. × 165.



HOLM on AMPHICARPUM

THE HABITATS OF THE RARER FERNS OF ALABAMA.

(WITH PLATE XXI)

INTEREST naturally attaches to any species of plants that grow near the borders of their geographic range. For this reason Alabama presents special interest to the student of ferns, because it is the southern limit of quite a number of ferns of the northern states, and also the northern limit of a few of the stragglers that come up from the south. The range of elevation, from the extreme lowlands of the Gulf region to the spurs of the Appalachian system that penetrate the state even beyond its center, is sufficient to give us a somewhat varied fern flora. Some forty species occur in the state exclusive of five species of Ophioglossaceæ.

The early exploration of the state was conducted by Judge Thomas M. Peters, and in later years Professor Eugene A. Smith and more especially Dr. Charles Mohr have the higher flora well in hand. I have been able to add to their list only a single species from the vicinity of Auburn, in the handsome swamp fern, *Dryopteris Floridana*, hitherto known only from Florida, where it is not uncommon. I am able also to reinstate a very distinct species of Botrychium which for many years has been masquerading under a false name. I give the characters and synonymy as follows:

BOTRYCHIUM BITERNATUM (Lam.).

Osmunda biternata Lam. Encyc. Meth. Botanique **4**: 650. 1797.

Botrypus lunarioides Michx. Flora **2**: 274. 1803.

Botrychium lunarioides Swz. Syn. Fil. 172. 1806 (not Gray: Manual, etc.).

Botrychium ternatum var. *lunarioides* D. C. Eaton, Ferns of N. Am. **1**: 148. *pl. 20, f. 3*. 1879.

Sporophyte with fleshy roots from which rises a short common stalk 1.5 ^{cm} or less high, bearing a nearly sessile broadly triangular ternately compound leaf 8 to 10 ^{cm} wide, 5 ^{cm} long; middle division slightly larger than the lateral ones and like them nearly bipinnate; ultimate divisions somewhat lunate, usually not exceeding 5 to 6 ^{mm} in width, the outer margin crenulate, the lateral margins decurrent into the short branches of the rachis: sporophyll on a rather stout slightly elongate stalk (8 ^{cm} or more long), bipinnate, with a rather broad rachis: spores pale alutaceous, 39 to 44 μ in diameter: bud for the

succeeding year enclosed in the base of the common stalk, smooth, the segments nearly erect or with the apices barely incurved.

Spores maturing in early spring (February or March in the latitude of southern and central Alabama). *Plate XXI.*

The plant was first collected by Michaux in South Carolina, and was described by Lamarck under the name of *Osmunda biternata*. Seven years later Michaux himself described it under the name of *Botrypus lunarioides*, while Swartz referred it to *Botrychium*, but unfortunately under the later name. Later writers confused all our northern forms that now constitute the somewhat variable *Botrychium ternatum* of our manuals under Michaux's name. Professor D. C. Eaton clearly distinguished this form and figured it in his *Ferns of North America*, but overlooked its very distinct leaf and bud characters, and supposed that its time of maturity was due to its southern station. As a matter of fact the true *Botrychium ternatum* is comparatively common in central Alabama, and produces its mature spores late in the season (August to October), the same as it does farther north. In Alabama the stations where *B. ternatum* is found are very different from those affected by this species. *B. ternatum* grows in moist places, frequently near the smaller water courses, while *B. biternatum* is found on dry, usually grassy, knolls, or dry pastures.

My attention was called first to the unusual fruiting time of this species by Dr. Mohr, while looking through his collection of ferns last winter. He regarded the form as found at Mobile as a distinct species. In the following March I found a single plant growing on a grassy knoll in Auburn, when I recognized clearly the distinctness of the species, and this conclusion has been fully confirmed by the bud characters as well as the spores. I find several specimens from South Carolina in the collection of Columbia University, and shall be glad to know of its further occurrence, since our present knowledge of its distribution limits it to these two states and Georgia, which was the source of Eaton's figure above cited.[3] Judging from the single specimen found by myself, collectors will have to get down on their knees more if they expect to find this plant, and the same is true of some of the other small Ophioglossaceæ of the Gulf states.

The species is readily distinguished from *B. ternatum* by its nearly sessile and more compound sterile leaf, as well as by the form of its ultimate divisions, which are distinctly rounded and short, lacking the

[3] Eaton's figure represents a small and possibly immature plant.

characteristic long, more or less pointed form common to that species. Its time of maturing its spores also clearly distinguishes it from *B. ternatum*. Moreover, *B. ternatum* is characterized by its hairy bud, a character which is constant in Alabama specimens, while the bud of *B. biternatum* is smooth.

There are some other distinct species that have been lumped with *B. ternatum* which must be separated, if indeed our northern species is the real *B. ternatum* Thunb. originally described from Japan; one of these species at least is American, but I wait for additional material to confirm this view. It is almost incomprehensible how such entirely distinct species can be thrown together in composites as has been repeatedly done by the English authorities on ferns. This is the common condition met with by any one who undertakes the study of these plants in their native haunts the world over. Jenman has found this true in Jamaica; Mr. Davenport and myself in Mexico; and I have found the same thing in a recent study of Hawaiian ferns.

Another interesting find in the vicinity of Auburn is the rare *Ophioglossum crotalophoroides*, which occurs in low grassy bottoms, and is occasionally found on gentle grassy slopes. It grows with its bulb deeply buried in the earth, the base of the sterile leaf barely rising above the surface. This station is the farthest inland the plant has yet been found.

The common ferns of central Alabama, aside from the ubiquitous *Pteris aquilina*, and *Polypodium polypodioides* on tree trunks and rocks, are *Woodwardia areolata*, *Asplenium filix-fœmina*, *A. platyneuron*, and *Dryopteris acrostichoides*, the latter almost at its southern limit. *Cheilanthes lanosa* is abundant on metamorphic rocks, *Woodsia obtusa* is occasional along streams, while *Dryopteris Noveboracensis* is occasionally found in damp woods; rarely *Dryopteris patens* will be found in exceptionally moist places; *Dryopteris Thelypteris* regularly and *Onoclea sensibilis* and *Phegopteris hexagonoptera* occasionally inhabit the open marshes. Of the Osmundaceæ, *O. regalis* and *O. cinnamomea* are not uncommon. These data apply more especially to the eastern central portion, and more particularly to the vicinity of Auburn in Lee county. Here we have an elevation of something like eight hundred feet, and this ridge forms almost the extreme extension of the Appalachian chain. As we descend from this elevation a few miles to the southward and westward, the more northern species disappear and only the species of the southern lowlands remain.

It is, however, the northern and northwestern portion of the state that presents more of interest to the fern hunter as well as to the botanist interested in any branch of the subject.

Two exceedingly interesting localities were visited during the months of May and June of the present year, and a considerable series of rare and interesting species were obtained, which have been distributed to the leading herbaria.

The first of these localities visited was Havana glen, which had been known as one of the stations of the rare *Asplenium ebenoides*, collected here many years ago by Miss Julia Tutwiler. Havana is a hamlet of a half dozen houses and shanties, in Hale county, and is reached by private conveyance either from Stewart's or Akron on the Alabama Great Southern railway. The glen is a deep gorge cut in a conglomerate rock, well wooded and shaded. Here, in addition to the ferns mentioned above, we find *Dryopteris marginalis*, commonly reduced in size so that mature spore-bearing fronds six inches long are not uncommon; also *Adiantum pedatum*, and on the rocks *Asplenium trichomanes* and *Camptosorus rhizophyllus;* here, too, we find *Botrychium Virginianum* of normal size. But the object of our search is here in considerable quantity, in fact the commonest fern of the glen, *Asplenium ebenoides*, originally discovered along the Wissahickon near Philadelphia, reported from a dozen stations ranging all the way from Canaan, Connecticut, to Hanover, Indiana, and southward, but, so far as I can discover, nowhere found in any quantity. Many have regarded it a hybrid, but the display of the species at Havana clearly demonstrates that it is not a hybrid at all. Its nearest congener is *Asplenium pinnatifidum*, but the frond is much thinner and more irregular than that species. In habit, however, it is very close to that species, growing far under overhanging rocks; in this respect it is totally unlike both *A. platyneuron* and *Camptosorus rhizophyllus*, its supposed parents. It appears to be multiplying, as many young plants were seen in the rock crevices. This myth of hybridity may be put aside, for *Asplenium ebenoides* is as clearly defined a species as we possess in the genus Asplenium, and has no near relations outside of its own genus.

The other habitat for the rarer ferns of Alabama is the old collecting ground of Judge Peters, and the type locality of *Trichomanes Petersii*, which will rank as the rarest as well as the most minute representative of its order in the country. Winston county, Alabama,

noted for being one of the few Republican counties in the state and for the possession of only a single family of blacks, is a wild unsettled region toward the northwestern portion of the state, with a railroad crossing it at its southwestern corner. It must therefore be reached, if at all, by private conveyance. It is about equally near to Cullman and Decatur, and from either place would require a ride of about forty miles over a rough mountain road. It could also be reached from Haleysville, whence we made our exit, but railroad connection is uncertain in this direction, as we found, being obliged to wait twenty-one hours for a train. The distance in this direction is only about twenty-five miles, but the means of transit are mostly in the form of sharp-angled mules, and if the streams are "swimming" you are not certain to reach your destination the same day, or even the same week, particularly if you have any desire to keep your collections dry.

The people, as might be supposed, are primitive in their habits as well as quaint in their language, but are hospitable, and will share with you their best accommodations, and treat you well if you are not prone to show too much anxiety as to the place where they manufacture "mountain dew," a product of the mountains which is not mythical! In their gardens they cultivate old English herbs that are rarely seen elsewhere in this country, and they preserve many of the old English expressions and forms of speech. The region is heavily timbered, with very little cleared land, and the flora is of exceeding interest. It is the home of the magnolia, no less than five species growing here, one of them with leaves that often measure three feet in length and nearly half as wide as long. Most of the trees are of the deciduous types, with occasional areas of pine and a few hemlocks scattered among the ravines.

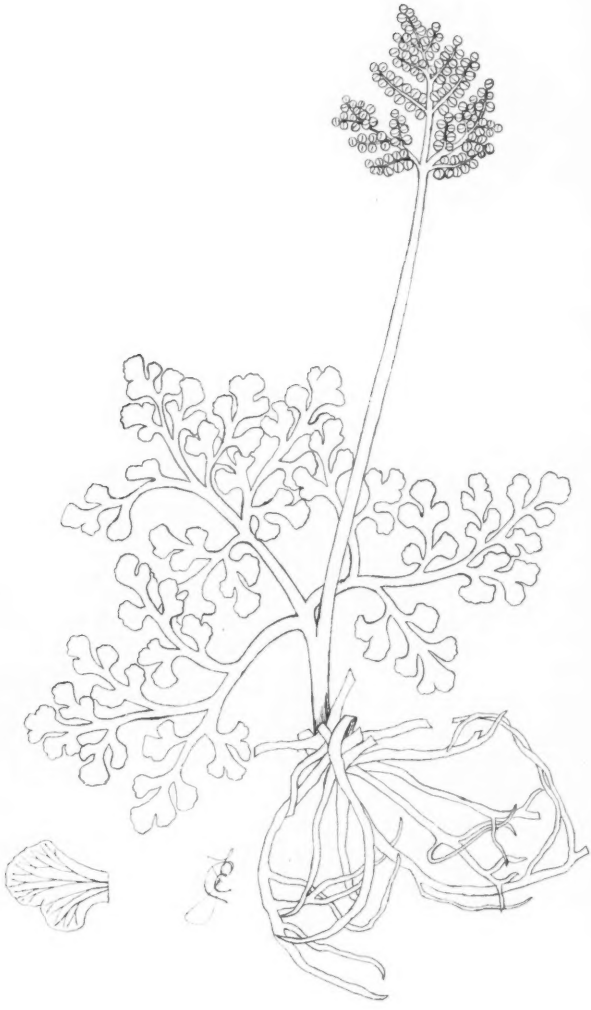
Here we find more of the northern types of ferns, among them many of the common ferns of the northern states. Among them are *Polypodium vulgare*, *Dryopteris spinulosa intermedia*, *Asplenium thelypteroides*, *A. angustifolium*, in addition to most of those mentioned above which are here in greater abundance. Nowhere, however, do we find anything of the profusion of ferns so common in the woodlands of the New England and Middle states. On the rocks, if limestone, we find *Pellæa atropurpurea*, which a little farther east (near Huntsville and Fort Payne) rendered us a most interesting series of young plants, commencing with cordate entire leaves, varying with age to broadly tri-

angular hastate, and later developing forms that are made up of three pinnæ, the terminal one often very broad and hastate, as in the case of the earlier simple ones.

On the sandstones and shales we find *Asplenium pinnatifidum* and *A. montanum* in great abundance. In similar formations, usually in dark shaded ravines and underneath broad shelving rocks, deep in the darkest recesses, *Trichomanes radicans* grows in the greatest profusion. Nowhere within our experience in this country does the tropical character of fern vegetation manifest itself more strikingly than it does here under these dark and gloomy shelves where, in a minimum of light, beds of this filmy fern twenty feet long and two or three feet wide thrive in the slight but perpetual drip of the water that percolates through the rocks. Not even in the swamps and sink-holes of southern Florida, where the ferns of the tropics still persist in greater variety, is there so striking an impression of tropical luxuriance and the peculiar clammy moisture that one expects in tropical vegetation.

The rarest fern to find, however, even when you are near its station, is the elegant *Trichomanes Petersii*. Within the section[4] that contains the type locality it took two days of very earnest search to find it. From the description of the original station I had expected to find it "on rocks wet with the spray of waterfalls," but all such over moist localities yielded no returns. When I had almost given up the search I found it at last creeping under the roof of shelving rocks, sending up at intervals of one or two centimeters its tiny fronds that look more like the leaves of a large *Mnium* than a fern; it occasionally forms matted masses of fronds like those distributed by Judge Peters years ago, but it is distinctively a creeping plant. I learn from Dr. Mohr that the plant is found at one or two other stations, but so far it is not known outside of Alabama. Its minute size, however, and its unusual habitat would evade one not familiar with its habits, and it may have a wider distribution than I now suspect for it. But before these things will be known we need any number of people, call them botanists or what you may, who know plants, their haunts and habits, who love the fields and woods and search them with the zeal that prompted Peters and Beaumont and the other earlier botanists of Alabama to make known their native flora.—LUCIEN M. UNDERWOOD, *Auburn, Ala.*, now of *Columbia University*.

[4] T. 8. R. 9. Sect. 10, Winston county.



BOTRYCHIUM BITERNATUM (Lam.) Underw.

EXPLANATION OF PLATE XXI.

Botrychium biternatum (Lam.) Underw., natural size, with segment enlarged. Drawn by Miss Julia E. Clearwaters, from herbarium specimen collected at Auburn, Ala.

A NEW SMUT.

I WISH to call the attention of mycologists to one of the Ustilagineæ which presents some features of interest. It is of the Doassansia group and occurs in the culms of *Glyceria fluitans*, the white mycelium ramifying through the tissues and in the central cavity. The wall of the young sorus is formed of coherent brown hyphæ arching from base to apex. Outside of the wall are a few white unmodified hyphæ extending from the base to or toward the apex. When the young sorus is crushed in water under a cover glass the contents are seen to consist of a transparent substance which protrudes from the rent in the wall of the sorus like the ascus of a Sphærotheca, and which is immediately withdrawn into the sorus when the pressure is removed. When the sorus is mature the spores are irregularly one to three deep on the surface, lying upon dark brown pseudoparenchyma which constitutes the greater part of the sorus, but which is limited internally by a narrow layer of hyphæ lining a central cavity into which the free ends of the hyphæ project a few micra. It may be that the parenchymatous tissue in time fills the sorus, as I have not sectioned sori that had germinated.

The sori are most readily found in the central cavity of the host, loosely attached to its walls, and are most common in the lower internodes. It was collected at Racine, Wisconsin, and Mr. H. F. Lueders kindly searched for and found it at Sauk City, Wisconsin.

I found it difficult to induce the spores to germinate. Material, however, that had been collected the previous year and kept continuously exposed to the weather was found to be germinating in the latter part of September. Sori from this material placed in distilled water on a slide in a moist chamber showed slender promycelia projecting from the sori, each of which bore at its apex a globule of fluid within which the sporidia were formed, the globules increasing in size as the sporidia developed. When two globules came in contact they coalesced, and thus the sporidia of two or more promycelia would lie in a single globule. These globules resemble oil droplets in appearance. One

germinating sorus from which the culture drop had receded put forth long hyaline somewhat sinuous filaments, the branches (lateral) of which resembled promycelia and bore globules at their tips. The after development of the sporidia I have not seen. The structure of the mature sorus of this fungus seems to approximate it to the genus Burrillia, established by Dr. Setchell for a species growing in the leaves of Sagittaria.[5] It may be characterized as follows:

Burrillia globulifera, n. sp. Sori globose to elliptical, dark brown or black, surface uneven, 250–450 μ in diameter. Spores one to three deep on the surface of the sorus, dark brown, closely compacted, irregularly polyhedral, 6–9 μ in diameter. Sorus beneath the spores composed of dark brown pseudoparenchyma limited within by a narrow layer of hyphæ enclosing a central cavity. Development of the sorus centripetal. Germination of the spores in the sorus. Promycelia about 2 μ in diameter, 30–80 μ long, brownish, studded with numerous minute rounded prominences. Sporidia 4 to 8 or more, terminal, whorled, cylindrical, 12–18 × 3 μ, formed in a globule of fluid.

In the culms of *Glyceria fluitans* R. Br. Racine and Sauk City (*Lueders*), Wisconsin. October and later. To be distributed in Ellis and Everhart's *North American Fungi*, no. 3481.—J. J. Davis, *Racine, Wisconsin.*

[5] Annals of Bot. **6**: 36–37. 1892.

EDITORIALS.

An American Tropical Laboratory

THE WORK that has been done and undertaken at Buitenzorg, and the various problems in which American botanists are interested and which need tropical conditions for their proper investigation, constrain us to believe that the time has come for the establishment of a laboratory in the American tropics. The science of botany in general, so far as morphology, physiology, and ecology are concerned, rests largely upon the results of researches carried on in the north temperate zone, in gardens and laboratories situated between the parallels of 40° and 55°. While taxonomy has had world-wide material for its superficial diagnoses, and has reached a fair measure of knowledge concerning the general relationships of plants, knowledge of these other great divisions of the science has been derived from a study of the plants indigenous to a strip of territory fifteen degrees in width and extending across one continent and partly across another, and of those introduced from other regions and growing under abnormal conditions of climate or substratum in the open air and in conservatories. That many of the conclusions reached under such circumstances are not capable of general application is becoming more and more apparent.

IN ORDER to come in contact with the problems that are now pressing, the botanist must establish his laboratory in the midst of the normal conditions, and no condition is so vitally needed by botanical research, and so overwhelmingly lacking, as that furnished by the tropics. In consequence of this, the garden and laboratories at Buitenzorg already have furnished opportunities for many important discoveries, and have become a sort of Mecca to the botanists of the world. But to an American botanist Java is a hemisphere away, and a visit to Buitenzorg is equal to a trip around the globe. A month is necessary for the journey each way, and the cost of it, including but a brief stay at the laboratory, is about twelve hundred dollars.

THE AMERICAN BOTANIST needs to make no such journey. At the distance of a week's travel from almost every important laboratory there lies a tropical region whose teeming flora is but little known, even to taxonomists. At our very door there lies a vast *terra incognita*, with excessively luxuriant vegetation, and inviting endless research. The duty seems to be laid upon American botanists to establish and maintain an international laboratory in the American tropics, one which American botanists can visit at small expense during a summer vacation, or upon a short leave of absence, and in which the observer in the oriental tropics would find still other revelations. It is impossible to overestimate the value of such an institution, not only to American botany, but to the science in general.

THE ESTABLISHMENT of such a laboratory might be accomplished most easily by the cooperation of several universities, for its intercollegiate character should be maintained. Perhaps the original cost should be borne by private subscription, and the running expenses met by the different universities pledging themselves for so many tables. At least the subject deserves to be taken in hand by a committee of botanists and investigated in all of its bearings. A study of the map will show that the conditions to be met favor either the eastern coast of Mexico or the islands near the Caribbean Sea. It is estimated that a trial station might be maintained on one of these islands for one year at a cost of $5000; and after the selection of a permanent station the laboratory buildings might be constructed and extended according to the demand. The use of grounds necessary could be obtained from the government, and the area should embrace all possible levels so far as possible, a feature at Buitenzorg which is nearly ideal.

IT IS TO BE HOPED that a reconnoissance party of American botanists will soon visit the region proposed and report as to possible sites. Such a visit should be made before the botanical meetings of next summer, to which the report would be most appropriately made.

OPEN LETTERS.

SCIENTIFIC CHIEF FOR THE DEPARTMENT OF AGRICULTURE.

To the Editors of the Botanical Gazette:—The editorial in the GAZETTE for September relative to a scientific chief of the Department of Agriculture gives an entirely wrong impression as to the position of those in charge of the botanical work here. So far as I am aware, the entire scientific corps of the Department are in favor of a chief such as is contemplated. My open letter in the GAZETTE for September has no bearing upon this question, but was written in answer to the statement that there is a dissipation of energy and a duplication of work in the botanical branches of the Department, and that this could be avoided by certain changes, which, in the judgment of the writer, would destroy the autonomy of the present divisions.—B. T. GALLOWAY, *Washington, D. C.*

THE CHECK-LIST[1] AND THE NEW ILLUSTRATED FLORA OF NORTH AMERICA.[2]

To the Editors of the Botanical Gazette:—Ever since the publication of the above cited *Check-list* many and very diverse opinions have been expressed as to the advisability of adopting this work with its numerous changes in nomenclature. The various discussions upon this subject have, however, been largely confined to the question whether such changes are advisable or not, while very little has been said about the possibility of making all these changes. We should like, therefore, to submit to American botanists a brief statement of this phase of the question: the possibility of correcting old names.

It appears to the writer that some of the requirements that are most needed for undertaking this kind of work are: (1) access to the type-specimens, (2) a broad linguistic knowledge, (3) a thorough familiarity with botanical terminology, (4) a long continued study of systematic botany in field and library.

[1] List of Pteridophyta and Spermatophyta growing without cultivation in northeastern North America. Prepared by a committee of the Botanical Club. New York: 1893–4.

[2] N. L. BRITTON and HON. ADDISON BROWN: An Illustrated Flora of the Northern States and Canada. New York: 1896.

We would ask whether the lately published volume of the illustrated *Flora of North America* is really sufficient to satisfy American botanists in regard to these requirements, so that the *Check-list* may be unanimously adopted. That the *Check-list* and the new *Flora* are closely connected is evident when we look at the names of the authors and contributors, although two have withdrawn from the former publication. We can, therefore, with good reason compare the character of the *Check-list* with that of the illustrated *Flora*, and we feel inclined to think that the order of publication ought to have been first the *Flora* and afterwards the *Check-list*.

Without going into details as to these publications, at least not in this place, we desire to submit the following questions in order to secure an early discussion of the matter:

1. Does the family diagnosis in the illustrated *Flora* seem sufficient to separate closely related families, and have the most important distinctions been given?

2. Does the terminology correspond with well recognized usage at home and abroad?

3. Are the descriptions correct in regard to morphology, as adopted in leading systematic works?

4. Does a consideration of this *Flora* with these questions in mind satisfy the botanist that the authors of the *Check-list* were in full possession of the necessary requirements?—THEO. HOLM, *Washington, D. C.*

THE NATIONAL HERBARIUM AND THE DIVISION OF BOTANY.

To the Editors of the Botanical Gazette:—In view of an evident lack of correct information regarding the recent change in the custody of the National Herbarium it has seemed desirable that a brief sketch of the present relationship and work of the Division of Botany and the Herbarium be presented to your readers.

During at least the past three administrations, covering a period of nearly twelve years, there has been a feeling among the authorities of the Department of Agriculture that the Division of Botany should be relieved of the custody of the National Herbarium, that institution having grown beyond a mere consulting herbarium to the dimensions of a great governmental repository of botanical collections, thereby becoming a fit charge for the Smithsonian Institution. As a result of negotiations between the two establishments, the herbarium was transferred about two years ago from the Department of Agriculture to quarters in the fireproof building of the National Museum, which is under the direction of the Smithsonian Institution, the Department, however, continuing to furnish the money for its maintenance.

But on July 1, 1896, the Museum assumed complete charge of the Herbarium, being enabled to provide for it through an increase of $10,000 in the appropriations of the Museum, added by Congress for this special purpose. The disbursement of this sum for the National Herbarium is made, therefore, through the Smithsonian Institution. Two assistant curators, Dr. J. N. Rose and Mr. C. L. Pollard, have been transferred from the Department of Agriculture to the Museum, with the necessary clerical help, and a new assistant curator of the cryptogamic collections, Mr. O. F. Cook, appointed, the botanist of the Department of Agriculture, Mr. Frederick V. Coville, continuing to serve, without salary, as curator. Provided with a force of ten people, in addition to the curator, situated in fireproof quarters, and managed by the Smithsonian Institution, the National Herbarium is now favorably situated to continue its development as the repository of the botanical collections acquired by the various branches of our government.

The Division of Botany in the Department of Agriculture has now a force of twenty persons, including clerks and laborers, and funds to the amount of $29,000 available for the expenditures of the present fiscal year. Mr. Frederick V. Coville is botanist and chief of division and is especially engaged in work upon the native plant resources of the United States and upon the geographic distribution of plants. Mr. G. H. Hicks is assistant chief and has special charge of seed investigations and the laboratory equipped for that purpose. Mr. L. H. Dewey has charge of all matters relating to weeds, information about the damage done by them, their present distribution and means of dissemination, ways of holding them in check, and warnings about newly introduced species. Mr. V. K. Chesnut has charge of the pharmacological laboratory and conducts investigations on poisonous plants, more particularly those native species which are a common cause of poisoning in man or domestic animals. Mr. A. J. Pieters has charge of the anatomical and photographic work of the division, and is conducting a special series of experiments on the germination of weed seeds. Mr. W. W. Tracy, recently appointed from the seed farm of D. M. Ferry & Co., has charge of greenhouse and outdoor variety tests of seeds and of the cultivation of native food and other economic plants. Mr. J. C. Dabney is assisting in experiments in seed selection and is making studies of the effect of various chemicals upon germination. Mr. Sothoron Key has charge of laboratory germination tests, is conducting practical trials of the relative merits of various kinds of laboratory apparatus, and is making studies in regermination. Mr. John B. Leiberg is carrying on the greater part of the field work connected with the special studies of the botanist. Mr. F. A. Walpole is the artist of the division, recently appointed after passing the highest examination among twenty-one competitors.

The Division of Botany as at present organized is an establishment

equipped with the best scientifically trained men obtainable, and with the best modern applicances, for the investigation of agricultural botanical problems.—FREDERICK V. COVILLE, *Washington, D. C.*

THE FLORA OF ALABAMA.

To the Editors of the Botanical Gazette: Having just returned from a three months' trip through the north my attention was called yesterday (Sept. 4) for the first time to the severe criticism of my bulletin in the BOTANICAL GAZETTE issued in July. The article would give me little concern but for the unjust charge that I had treated Dr. Mohr with unfairness because he "granted me a favor that has been abused." Eliminate this feature of the "review" and there is little for me to complain of. The article of which I complain is so cruelly unjust and there is such a tone of keen sarcasm pervading the entire paragraph I cannot refrain from entering my protest and demanding at least a fair statement of the facts. There is the most friendly relationship existing between Dr. Mohr and myself, and if there has been any complaint on his part of slight or "favor abused," I am yet to hear of it. A careful reading of the bulletin will show that I have been very punctilious in giving Dr. Mohr ample credit for all the assistance he has rendered me; not only after each species is his name printed, but on page 279 the following occurs: "The author acknowledges with pleasure material assistance from Dr. Chas. Mohr of Mobile in locating many of the species mentioned in this bulletin." In several instances his name is given alone, although I had also gathered specimens in the same county. It seems to me there is no injustice done Dr. Mohr in giving him credit for all information secured from him, and there can be no interference with his proposed work on the botany of Alabama, since my bulletin is simply a list of localities and nothing more, while his book will give full details in all matters relating to the plant. I am confident from what I know of Dr. Mohr he cannot consider my list as antagonistic to his work. Before publishing my bulletin I sent the list of species to Dr. Mohr and requested him to examine it carefully and give me the names of other counties if possible. I stated in my letter that it was my intention to publish the list as one of the bulletins of the state station, and I would like to get his consent to use his information. In reply to this letter he not only gave me the additional counties asked for, but was kind enough to add a few other species to my list (he added 19). I give below a copy of his letter which clearly shows his willingness to permit me to use his information as requested in my letter to him.—P. H. MELL, *Auburn, Alabama.*

MOBILE, March 13, 1896.

PROFESSOR P. H. MELL, *Dear Sir:* Your favor of the 11th came duly to hand. It gives me pleasure to return herewith your list of Leguminosæ and Rosaceæ, accord-

ing to your request, with the localities known to me in Alabama. I have added several species of these orders not mentioned by you. I am anxious to learn if any of the plants enumerated by you, and which I could not locate in the state, have been observed by you within its limits, and if you have collected any specimens of them, I shall be greatly obliged to you if you will give me the localities of such to be inserted in my forthcoming Flora of the state. Any contribution will be gladly received and I need scarcely say that due credit will be given to all whom I have to thank for their kind assistance. I remain yours very truly.

CHARLES MOHR.

[The above is an extract from a private letter from Professor Mell, only those parts being omitted which pertain to the other features of the criticism referred to. This publication has been delayed by a desire to discover the real facts in the case. The GAZETTE is glad to say that Professor Mell should be exonerated from any intention to abuse the information received from Dr. Mohr. He certainly has acted in good faith as he understands it. The GAZETTE can only add that as it has been known for a long time that Dr. Mohr has had in preparation a "Flora of Alabama" the appearance of an independent publication under the same title, and using much material obtained from Dr. Mohr, seemed to need explanation, especially as no reference to the forthcoming work of Dr. Mohr was made. It is true that the information obtained from Dr. Mohr is credited, but the more important statement concerning the use Dr. Mohr was expecting to make of his material, and that the present list was intended in no way to interfere with it, would have explained the situation. Professor Mell has worked for many years in a botanical region peculiarly rich, and there is no reason why he should not have made large contributions to our knowledge of the flora of Alabama, contributions which when substantiated by herbarium material would justify the publication of a state list contemporaneous with another prepared by a very competent botanist.—EDS.]

CURRENT LITERATURE.

MINOR NOTICES.

MR. A. P. MORGAN has just published his fourth paper upon the Myxomycetes of the Miami valley (Ohio),[1] containing the Physaraceæ. Out of Physarum of Persoon's *Synopsis* (1801) seven genera have come, which with Fuligo and Craterium makes this family the largest one of the Myxomycetes. Mr. Morgan has followed Lister in discarding Tilmadoche of Fries, but he has separated from Physarum a new genus, *Cytidium*, characterized by the presence of a columella, and composed for the most part of very closely related species. Both Leocarpus and Craterium have been enlarged to receive two or three species of Physarum. Scyphium of Rostafinski is restored, being characterized by the form of the sporangium and the prolongation of the stipe into a columella. Examination of the forms merged by Rostafinski under *Fuligo varians* has decided the author to return to the species of Persoon. A fifth paper is intended to close the series.— J. M. C.

MR. P. A. RYDBERG has published the results of his study of the North American species of the perplexing genus Physalis.[2] No genus was in greater need of careful revision, as the species are difficult to separate, and apparently most of those recognized were composites. To their disentanglement Mr. Rydberg has brought great patience, a good insight, and an abundance of material. His examination of herbarium material has been unusually complete, and much field work has served to make this examination profitable. When many accepted species are represented by a plexus of species the synonymy becomes peculiarly difficult, and the author confesses to the chaotic condition in which he found the synonymy of Physalis. A full and critical discussion of the species precedes their synoptical presentation, in which are included the five allied genera Margaranthus, Quincula, Leucophysalis, Chamæsaracha, and Orcytes. Margaranthus contains four species, one of which (*M. purpurascens*) is new. Of Physalis thirty-nine species are recognized, with the statement that many remain undescribed, notably Mexican forms. *P. pubescens*, as formerly recognized, is broken up into *P. pubescens* L., *P. pruinosa* L., *P. Neo-Mexicana*, n. sp., *P. Barbadensis* Jacq., and *P. Lagascæ* Roem. & Sch. *P. lanceifolia* Nees is separated from *P. angulata* L. *P. ixocarpa* Brot. replaces *P. æquata* Jacq. *P. lanceolata lævigata* Gray becomes *P. longifolia* Nutt., and the allied *P. Texana* is described

[1] MORGAN, A. P.—The Myxomycetes of the Miami valley, Ohio. Jour. Cincinnati Soc. Nat. Hist. **19**: 73–110. *pl. 13–15*. 1896.

[2] RYDBERG, PER AXEL.—The North American species of Physalis and related genera. Memoirs of the Torr. Bot. Club **4**: 297–374. 1896.

as new. *P. lanceolata hirta* Gray is *P. pumila* Nutt., and *P. Virginiana* Mill. is separated from *P. lanceolata* Michx., while *P. Virginiana* Gray and *P. viscosa* Pursh become *P. heterophylla* Nees. *P. ciliosa*, n. sp., is from the Gulf states, *P. rotundifolia*, n. sp., is from the West, *P. hastata*, n. sp., is from Lower California. The genus *Quincula* Raf. is recognized, and includes *Physalis lobata* Torr. *Leucophysalis* is a new genus constructed upon *Physalis grandiflora* Hook. It seems that *Chamæsaracha Coronopus*, as recognized, was a plexus, from which the author has separated *C. crenata*, n. sp., and *C. conoides* Britton (*C. sordida* Gray). *Orcytes* Wats. still remains a monotypic genus.—J. M. C.

NOTES FOR STUDENTS.

THE FIRST FASCICLE of *Pringle's Mexican Fungi* has recently been distributed by the Cambridge Botanical Supply Company. It consists of ten numbers, as follows: 1. *Puccinia heterospora* B. & C. on Anoda; 2. *P. heterospora* B. & C. on a malvaceous plant; 3. *Uromyces effusus* (Pk.) DeToni on Rhus Mexicana; 4. *U. Sophoræ* Pk. on Sophora sericea, uredospores; 5. Same, teleutospores; 6. *Æcidium Solani* Mont. on Solanum torvum; 7. *Æcid. Anisacanthi* Pk. on Anisacanthus virgularis; 8. *Parodiella perisporioides* (B. & C.) Speg. on Indigofera; 9. *Puccinia Tetramerii* Seym. on Tetramerium aureum; 10. *Leptostroma vestita* S. & P. on Agave vestita. The specimens are well put up and bear printed labels. The publication is edited by Mr. A. B. Seymour. Nos. 9 and 10 are new species; the descriptions accompany the specimens. They are also described in the *Botanical Notices*[3] of same date. As neither of these publications are likely to have a wide circulation, the descriptions are reproduced here.

Puccinia Tetramerii Seymour (Pringle's Mexican Fungi, No. 9, September 1, 1896).—Spots none; sori amphigenous, varying from minute to 5^{mm} in diameter, very dark; spores elliptical, covered with coarse blunt warts, dark, with broad and blunt apiculus somewhat lighter and occasionally a similar less prominent projection at side of spore; size of spore 11–15.5 × 33–42 μ; pedicels about 78 μ long, colored at junction with spore, otherwise hyaline, rough below.

On leaves of *Tetramerium aureum* Rose. Tomellin Cañon, Oaxaca, Mexico, November 30, 1895. Collector, C. G. Pringle.

Leptostroma vestita Seymour & Patterson (Pringle's Mexican Fungi, No. 10, September 1, 1896).—Amphigenous, mostly epigenous, stromata numerous, imbedded and slightly depressed, orbicular to oblong, .5–1^{mm} (rarely to 2.5^{mm}), covering most of the upper leaf surface, distinct or often confluent, olive with a narrow black margin; conceptacles 2 to 5 in a stroma; spores hyaline, linear, multiguttulate, guttulæ often elongated and appearing like vacuoles; size of spores 30–85 × 4 μ.

On leaves of *Agave vestita* Watson. Barranca near Guadalajara, Mexico, May 1891. Collector, C. G. Pringle.—J. C. A.

[3] A trade publication in the form of a card catalogue issued monthly by the Cambridge Botanical Supply Co.

MANY BULLETINS of the agricultural experiment stations contain matter that borders more or less directly upon botany, or have botanical matter interspersed among other subjects, thus rendering them of some interest to botanists. Of recent issues of this character are the following: A. D. Selby has mapped out the distribution of peach yellows in Ohio (Bull. 72), showing it to occur along the shores of Lake Erie in the north and in one county in the south part of the state. Considerable information is given regarding this disease, and also that of black knot of plum, with remarks upon some other diseases of fruit trees. L. H. Bailey (Cornell Bull. 117) figures and describes root galls upon apple trees, and also discusses some causes of winter injuries to fruit trees. The relation of loss of moisture through the bark to hardiness is examined with some original data on the loss of moisture from twigs of apple. F. C. Stewart (N. Y. Bull. 101) gives results of spraying potato plants, describes the internal browning of the tubers, which was found experimentally not to be due to bacteria or fungi, and not to be transmissible to the succeeding crop, and also describes two new stem blights of which the cause was not ascertained for one, and for the other a new species of Fusarium (*F. acuminatum* E. & E.) was detected. Thomas A. Williams reports (S. D. Bull. 48) tests with corrosive sublimate, eau celeste, and Bordeaux mixture for prevention of potato scab, the first being found most effective. Luther Foster gives results (Mont. Bull. 9) of trials in growing potatoes, including treatment for scab. L. F. Kinney (R. I. Bull. 38) treats of the use of Bordeaux mixture in preventing the phytophthora disease of potatoes. F. M. Webster (Ohio Bull. 69) examines the claim that *Sporotrichum globuliferum* and similar fungi can be used to hold the spread of the chinch bug in check, and comes to the conclusion that "these fungous diseases, in order to work sufficiently rapidly and effectually to benefit the farmer, require peculiar meteorological conditions and a superabundance of insects at the same time." In a bulletin by H. H. Nicholson and T. L. Lyon (Neb. Bull. 44) some good data are recorded on the use of large and small beet seed, and also on heavy and light seed. In a bulletin on apple culture by L. F. Kinney (R. I. Bull. 37) record is made of the number of flower buds on limbs fully exposed to the light and those in shade on the same tree, the average of ten examinations, including several varieties, giving 182 buds upon limbs in full light to 136 buds upon limbs in partial shade. The relation of the Burrill cornstalk (bacterial) disease and of corn smut to the cornstalk disease of cattle is quite fully treated in a bulletin by N. S. Mayo (Kans. Bull. 58), with the conclusion that both these plant diseases cause no derangement or disease in animals. R. J. Davidson (Va. Bull. 50) gives the chemical analyses of different parts of the tobacco plant taken at different stages of development. B. C. Buffum (Wy. Bull. 29) describes, with illustrations, some experiments upon the effect of alkali upon germination and growth, to show the nature of alkali soils. The relation of soil moisture to

vegetation is touched upon in a bulletin by L. A. Clinton (Cornell Bull. 120), and in one by F. W. Rane (N. H. Bull. 34), the latter treating of irrigation. — J. C. A.

THE BOTANICAL SEMINAR of the University of Nebraska has published, as a special brochure, an address recently delivered under its auspices by Professor Conway MacMillan, entitled "Some considerations on the alternation of generations in plants." The discussion is interesting and suggestive, and the "main contention" is summarized by the author as follows:

"The definition of rudimentary alternation should be widened so as to include rejuvenescence of the syngamete."

By "rudimentary alternation" is meant that form of it in which the indirect development of the sexually formed cell (syngamete) does not result in a distinctly organized body. In this category the author would include not merely the cases in which the syngamete produces directly several zoospores, as in Sphæroplea, but also those in which there is merely rejuvenescence, as in the zygospore of Spirogyra.

"Indirect development of a cell resulting from a sexual process is most fundamentally a sensitization and serves to compensate for that general sexual immobility which arises from the preponderant constructive chemism of plants."

Alternation of generation is generally spoken of as a device by which the product of the sexually formed cell is multiplied, and hence the more highly developed the sporophyte the greater the advantage. Our author, however, sees in it something deeper, which he calls "sensitization," by which he means the bringing of a syngamete cell "into more intimate reciprocal relations with the environment," as seen in a primitive way in rejuvenescence. This, he thinks, is an offset to the general stability of plants, a stability which follows from their essentially constructive character, as opposed to the destructive character of animals.

"Further development of alternation is accentuated by cleavage phenomena in the egg, and eventually a group of blastomeres becomes integrated as such and is the sporophyte. This body is peculiarly a plant product and in its origin and progressive specialization is as distinctly a structural response to the plant type of chemism as the head is a structural response to the animal type of chemism. Sporophytization, therefore, in the plant phylum, is a phenomenon of coordinate importance with cephalization in the animal, and homologies between the vegetative tracts of the higher plants and higher animals lie below the plane of the cell unit."

The author also presents a "classification of alternation of generations," which may be of interest to some as a new setting for old facts.

Alteration types.
- A. Recapitular alternation.
- B. Heteroblastic development.
- C. Sprout alternation.
- D. Homologous alternation.

Alternation types.
- A. Rudimentary alternation.
  - I. Rejuvenescence alone.
  - II. Rejuvenescence with segmentation.
  - III. Segmentation alone.
- B. Discrete alternation.
- C. Concrete alternation.
- D. Symbiotic alternation.

"Recapitular alternation" refers to "the passage from the vegetative multicellular to the reproductive unicellular condition;" "heteroblastic development" refers to such an alternation as that of Chantransia and mature Batrachospermum forms; "sprout alternation" defines itself; "homologous alternation" occurs where a potential gametophyte alternates with an actual gametophyte. These are styled "alteration types." The true alternation types are defined as follows: "Rudimentary alternation," defined above;" "discrete alternation," as in archegoniate plants (exclusive of gymnosperms); "concrete alternation," as among the Florideæ; and "symbiotic alternation," as in spermatophytes.—J. M. C.

MR. HAROLD WAGER has noted several new features in the development of the sexual organs of *Cystopus candidus*.[4] When these organs have reached their full size the oogonium contains 64 to 115 nuclei, and the antheridium 6 to 12. The protoplasm of the oogonium contracts toward the center, forming a central vacuolated mass surrounded by a denser layer, the periplasm. The nuclei divide and pass out into the periplasm, and one of these daughter nuclei moves toward the center and becomes imbedded in a dense mass of protoplasm which has collected there. Meanwhile the antheridial tube is being formed, and after nuclear division a daughter nucleus passes to the tip of the tube. When the tube reaches the dense mass containing the female pronucleus, the male pronucleus is discharged. A wall now appears around the oosphere, inside the periplasm. Fusion of the pronuclei soon follows. The fusion nucleus divides into two, and division continues until 32 nuclei are formed. This number is found in the resting oospore. Germination of the oospore was not observed. The division of nuclei in the sexual organs can hardly be regarded as a reduction process, for 20 to 24 chromosomes are found in the oosphere nuclei, and only 12 to 16 in the nuclei of the oogonium.—W. D. M.

MISS ETHEL SARGENT has investigated the formation of the sexual nuclei in *Lilium Martagon*.[5] The resting, vegetative nucleus contains a substance which she calls "amorphous chromatin." This is not present in the spirem stage, but the increased amount of chromatin in ribbon may account for its disappearance. The chromosomes split longitudinally after they have taken

[4] Annals of Botany **10**: 295, 1896.

[5] Annals of Botany **10**: 107, 1896.

their place to form the nuclear plate. In the resting stage the primary nucleus of the embryo-sac has the vegetative characters, but as division approaches the chromatin thread contracts to one side of the nuclear cavity, the nucleolus partially dissolves, and there is also a partial disappearance of the nuclear membrane. The nucleoli and membrane reappear in the spirem stage. The spirem of the embryo-sac nucleus differs decidedly from the vegetative type. The ribbon of the vegetative spirem stains like chromatin, but in this spirem there is an erythrophilous ribbon bordered by chromatin. Longitudinal fission of the entire ribbon takes place before segmentation into the lengths which become the chromosomes. The nuclei resulting from the second and third embryo-sac divisions resemble the primary nucleus in the staining of the ribbon, but otherwise they follow the vegetative type. After the second division the lower antipodal nucleus divides by the direct method.

The number of chromosomes in vegetative nuclei is generally about twenty-four; in the primary nucleus of the embryo-sac, twelve; but after its first division the micropylar nucleus has twelve, while the antipodal may have from twenty to thirty-two. Throughout the oogenesis twelve chromosomes seems to be a constant number for the micropylar end of the sac, but in the antipodal end the number varies from twenty to thirty-four. The transverse division of chromosomes, which Dr. Haecker suggested might precede the formation of the sexual nucleus, does not occur.—C. J. C.

SEVERAL physiological papers have recently been printed by Professor D. T. McDougal of the University of Minnesota, in part based upon experimental data, and in part upon critical deductions from the works of others. Additional papers on the same subjects are in course of publication, but those already upon the table are of sufficient importance to merit present attention.

His initial study, the mechanism and procedure of tendrils by which coiling is effected, has given, perhaps, the most important results.[6] Begun in the physiological laboratory of Purdue University in 1891, and continued as occasion permitted since, it has illuminated a number of obscure points, and done much toward making the whole matter of tendril movement understandable. The complex nature of the phenomenon is shown by the previous lack of discrimination between the act of coiling of the free part of the tendril, a function of maturity, and the sensitive response to contact.

The generalization is especially helpful that a class of plant movements dependent upon rapidity for effectiveness are only indirectly associated with

[6] For the earlier papers see this journal **17**: 205–212. *pl. 14.* 1892; **18**: 123–130. *pl. 10.* 1893; and Bot. Centralblatt **66**: 145, 146. —. The recent papers are two: "Ueber die Mechanik der Windungs- und Krümmungsbewegungen der Ranken," Ber. d. d. bot. Gesellschaft **14**: 151–154. 1896, and "The mechanism of curvature of tendrils," Annals of Botany **10**: 373–402. *pl. 19.* 1896.

growth and are brought about by the contraction of the concave side, while a class of movements where position is secured slowly, as heliotropic and geotropic curvature, are directly associated with growth and are brought about by elongation of the convex side. In Passifloreæ the region of maximum growth never coincides with the region of maximum irritability.

The morphological nature of tendrils is various, and the assumption that they may have various methods of producing movement is well made. The chief study has been given to tendrils of Passifloreæ and Cucurbitaceæ, which have similar structure. It is found that the pull of a stimulated tendril amounts to less than one-half gram, while that of a free coiling tendril is twenty to sixty times as great. In the first case rapidity of movement is the essential feature, and in the second the production of strains. By a variety of studies, including plasmolysis, it was ascertained that tendril movement in the two families named is always due to shortening of the concave side, a point which has been much in controversy.

The author brings support from various sources, including anatomical, for his conclusion that the cause of coiling resides in the irritability of protoplasm of the concave side, by which the protoplasts are rendered more permeable, water passing into the intercellular spaces, thus allowing the previously stretched cell walls to contract. Space does not permit mentioning other parts of the investigations.

A summary of present knowledge on the physiology of color in plants[7] shows that non-green colors convert the sun's rays into useful heat and in some parts of the plant promote transpiration, or are occasionally waste products of metabolism. Colors in some cases, as is well known, also hold relation to insect pollination and to protection from injury. Chlorophyll is also to be included as a very useful color.

The influence of carbon dioxide on the living protoplasm[8] appears to be characteristic. Its effects do not result from the simple exclusion of oxygen, but its action is upon the nutritive processes. Its stimulating action, if any, appears to be small.—J. C. A.

ITEMS OF TAXONOMIC INTEREST are as follows: Five new North American species of Saxifraga have been described by Dr. John K. Small.[9] A good figure of the very rare *Berberis Nevinii*, from the sandy plains near Los Angeles, has just been published.[10] *Lindauea* is the name of a new genus of African Acanthaceæ, dedicated by Dr. Donaldson Smith[11] to Dr. Gustav Linden. Professor E. L. Greene has issued another fascicle[12] of new and noteworthy species, describing two new species of Ranunculus, three of

[7] Pop. Sci. Monthly **49**: 71. 1896; Science **4**: 350. 1896.
[8] Science **3**: 689. 1896.
[9] Bull. Torr. Bot. Club **23**: 362. 1896.
[10] Garden and Forest **9**: 415, 1896.
[11] Jour. Bot. **34**: 411. 1896.
[12] Pittonia **3**: 91–98. 1896.

Delphinium, three of Roripa, and one of Berberis. He also takes up Sophia for *Sisymbrium incisum* and its allies, as an older generic name than Descurainea, adopted by Engler and Prantl, and proposes a new genus, Neobeckia, to include the watercress and horse-radish types of Nasturtium (Roripa), *N. lacustre* of the *Synoptical Flora* becoming *Neobeckia aquatica*. Miss Alice Eastwood[13] has described seven new Californian species belonging to the genera Sedum, Anemone, Hosackia, Lupinus, Heuchera, Brodiæa, and Cynoglossum. Mr. Robert Ridgway has suggested[14] the possibility of two native species of Tecoma, describing the forms as they have come under his observation, but applying no names. Mr. J. G. Baker[15] has concluded his synopsis of the genus Brodiæa, the last part touching upon several North American species. Mr. J. W. Toumey has described[16] a new Opuntia from Arizona, one of the shrubby cylindropuntias. M. A. Franchet has concluded his account of new Chinese plants.[17] The last part contains descriptions of twelve new species of Lonicera. Dr. C. Hart Merriam has described[18] a new Abies from Arizona. It is from the San Francisco Mountain region, and is remarkable for the color and character of its bark, being one of the most conspicuous trees on the mountain between the altitudes of 8950 and 9500 ft. The substance of the technical description is as follows:

ABIES ARIZONICA. About 15^{m} high: bark a highly elastic fine grained cork, whitish or grayish (usually creamy white), with irregularly sinuous grayish ridges: leaves of cone bearing branches thick, subtriangular in section, sharp-pointed at apex, about 2^{cm} long; leaves of lower branches much longer, flatter, blunt and notched at apex, 2.5 to 3^{cm} long: cones dark purple, slender, medium or rather small; scales much broader than long, strongly convex laterally, purple on both sides; bract (without awn) reaching to or past middle of scale, its body much broader than long.

A full account of *Aspidium cristatum* × *marginale* Davenport, published in this journal,[19] has just been given[20] by the author in connection with a Faxon illustration. A revision of the North American species of Cephalozia has been published by Professor L. M. Underwood.[21] In the fourth part[22] of Mr. P. A. Rydberg's Notes on Potentilla four new species are described. In his studies in the botany of the southeastern United States Dr. John K. Small[23] describes a new Rumex from Louisiana, revises the genera Polygonella and Warea, and substitutes Yeatesia for the previously used Gatesia of Gray.

[13] Proc. Calif. Acad. II. **6**: 422–430, *pl. 53–59*. 1896.

[14] Garden and Forest **9**: 453. 1896.

[15] Gardener's Chronicle III, **20**: 459. 1896.

[16] Garden and Forest **9**: 432. 1896.

[17] Jour. de Botanique **10**: 309. 1896.

[18] Proc. Biol. Soc. Washington **10**: 115–118. 1896.

[19] Bot. Gazette **19**: 494. 1896.

[20] Garden and Forest **9**: 444. 1896.

[21] Bull. Torr. Bot. Club **23**: 381. 1896.

[22] Bull. Torr. Bot. Club, *l. c.* 394.

[23] Bull. Torr. Bot. Club, *l. c.* 405.

NEWS.

MR. JOHN S. WRIGHT has been appointed lecturer in botany at the Indiana Medical College, a department of the Indianapolis University.

THE PROPOSED ESTABLISHMENT of an international botanical station at Palermo, Italy, under the direction of Professor Borzi, is announced by *Nature*.

AN ADDRESS upon "Grasses" by Professor F. Lamson-Scribner, delivered before the Massachusetts Horticultural Society, has been published by the society for distribution.

DR. A. P. ANDERSON is spending the present year at the Missouri Botanical Garden, where he finds suitable facilities for the further prosecution of his researches in connection with the resin ducts of conifers.

MR. M. A. LAWSON, botanist and director of cinchona plantations to the Madras government, died at Madras February 14th last. From 1868 to 1882 he was Sherardian Professor of Botany in the University of Oxford.

MR. WALTER T. SWINGLE returned in October to resume his duties in the United States Department of Agriculture after a year spent abroad. He studied chiefly in the laboratories of Bonn and the Biological Station at Naples.

ATTENTION is called by the biographer to an inaccuracy in the sketch of the late Professor Prentiss which appeared in this journal for May last. He was born May 22, 1836, in Cazenovia, Madison county, N. Y., not in Oneida county, as stated in the sketch.

DR. HERBERT M. RICHARDS, who has been studying in Professor Pfeffer's laboratory at Leipzig during the last year, having held a traveling scholarship from Harvard University, returned to this country in August, and is now installed as lecturer in botany at Barnard College, New York city.

NUMBERS 11 AND 12 of Lloyd's *Photogravures of American Fungi*[1] have recently been distributed. They represent respectively *Lepiota Morgani* Peck and *Sparassis Herbstii* Peck, two interesting species. The first was photographed as it grew in the field, and makes an unusually attractive and characteristic picture.

DURING A CYCLONE in the early part of October the roof of the main building of the Agricultural College at Lake City, Florida, was partly blown

[1] For notices of previous issues of this series see this journal **20**: 330, 556; and **22**: 75.

away and the interior deluged with water. The valuable private library of Professor P. H. Rolfs, especially rich in works on fungi and citrous fruits, suffered severely. The herbarium in an adjoining part of the building was but little damaged.

MR. GEORGE J. BURCH, of Oxford, England, has been experimenting upon plants with Röntgen photography. He finds that flower-buds and seed-vessels are especially favorable objects. He believes that if the photograph could be made upon a magnified scale the outline of every cell would be seen. The capsules of hyacinth and the flower-buds of fuchsia are reproduced in the account.[2]

A NOTABLE CACTUS GARDEN has been established at the University of Arizona. It is the purpose to bring together eventually all the Cactaceæ indigenous to the United States, and already more than a hundred species are represented. The region could not be more favorable for such a purpose, and for the first time there will be large opportunity for studying the group in its natural environment.

MISS ARMA ANNA SMITH, a graduate from Mt. Holyoke in 1891 (A.B.), and afterward Professor of Natural Science for three years in the American College for Girls in Constantinople, was engaged in botanical study at Cornell University last year, and received the degree of M.S. in June. Miss Gertrude Gibbs, a graduate of the University of Minnesota, also a student in botany the past year at Cornell University, received the degree of M.S., and is now Principal of the Jamestown High School, Jamestown, North Dakota.

DR. HENRY TRIMEN died at Peradeniya, Island of Ceylon, October 16th, in his 53d year. During his connection with the botanical department of the British Museum (1872 to 1879) he was the well known editor of the *Journal of Botany*, which commonly bore his name. In 1882 he became the director of the Royal Botanic Gardens at Peradeniya, and undertook to publish the *Flora of Ceylon*, three parts of which have appeared. His recent retirement from his official position, on account of ill health, has been noted already in this journal.

AN UNUSUALLY large fasciated stem of meadow thistle (*Cnicus altissimus* Willd.) was sent to the museum of Purdue University a short time ago from northern Indiana. When dry it measured twelve inches broad at the top and three inches at the base. The thickness of this greatly flattened stem was normal, that is, less than one-fourth inch. It was covered evenly with normal leaves, and bore a score or more of immature flower heads sessile along the upper edge. It stood three feet high. The interest in it lies in the size and perfect wedge form, as fasciated stems are usually irregularly developed.

[2] Gardeners' Chronicle III. **20**:491. 1896.

THE DAILY PRESS has brought the news of the death of Auguste Trécul, the venerable French botanist. He was born in 1818, and died October 16 in a hospital in Paris, and is reported to have been in a very destitute condition. His name as an anatomist was a more familiar one to botanists of a generation ago than to those of today, his principal papers dealing with the vascular system. During 1848 and 1849 he explored various regions of North America, and many of the cactus species of European gardens were first obtained by him during his travels in Texas and Mexico, as well as the beautiful Yucca which bears his name.

BARON FERDINAND VON MUELLER died at Melbourne, Australia, October 9th, in his 72d year. His is the most distinguished name in Australian botany, and his long and zealous study of that isolated flora has been of the greatest service to science. He left Europe in 1847, and never returned to it, but his enormous correspondence and his great collections always kept him in close touch with his foreign associates. His publications are very numerous, and many of them are noteworthy in presenting the most complete accounts of certain notable Australian groups, as Eucalyptus, Acacia, etc. An interesting biographical sketch will be found in *Gardeners' Chronicle* of October 17.

A VERY COMPLETE historical account of taxonomic nomenclature is presented by Dr. Theodore Gill in his vice-presidential address before the A. A. A. S. at its recent Buffalo meeting. The address is published in *Science* of October 23. In conclusion he seems to think that we must make the best of a too firmly fixed system. "The best thing to do now is to accept the current system, purified as much as possible by judicious and inexorably applied laws. Doubtless in the distant future a less cumbrous and changeable system of notation will be devised, but in the meantime we had best put up with the present, inconvenient though it be." In the same journal for November 6 Mr. J. A. Allen calls attention to the mischievous practice of determining priority by the date of printing, rather than by the date of publication, which is frequently quite a different date.

THE SECOND PART of volume sixth of the *Flora Capensis* has been issued from Kew, and, like the first part, is the work of Mr. J. G. Baker. It contains the continuation of the Amaryllideæ and part of the Liliaceæ, to the completion of which the whole of the third and concluding part will be devoted. A considerable number of species appear to have been collected but once. Many are still known only from descriptions and figures published in the last century, and are unrepresented in herbaria. It is difficult, however, to believe that they are really extinct. The fact is more probably accounted for by the extremely local limitation of species in South Africa, which is hardly paralleled in this respect by any other flora in the world.—W. T. T. DYER, in *Kew Bulletin*.